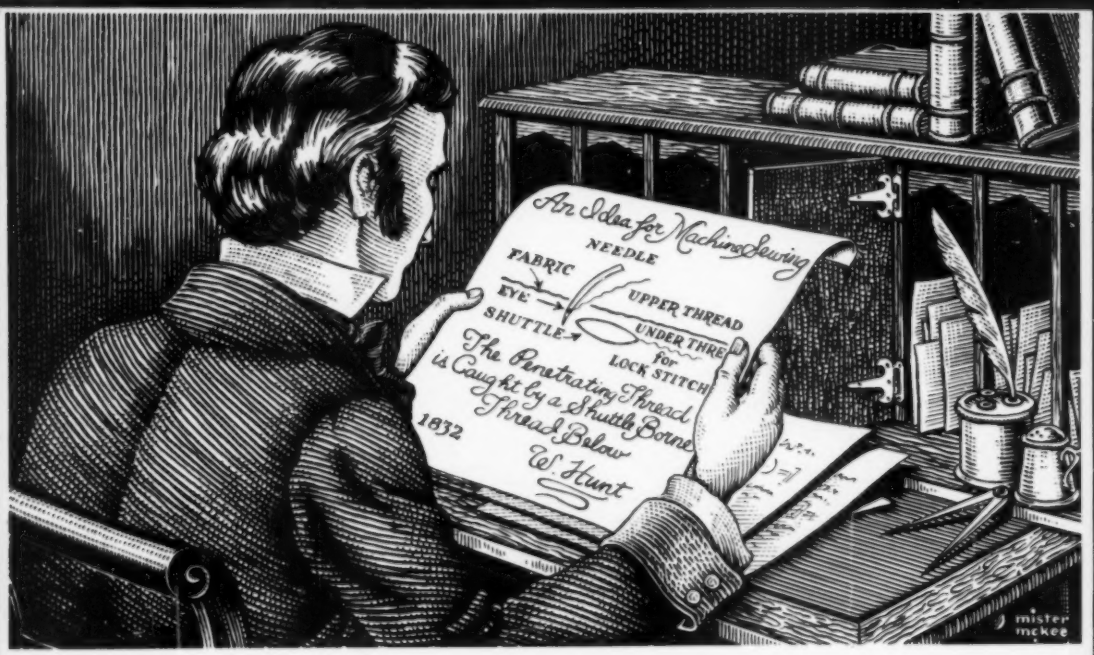
Product Engineering

JULY 1953

Brazing Titanium
Multi-Purpose Grease
Motors for Hazardous Locations
Residual Stress
Pneumatic Safety Circuits
Simple Approach to Cost Estimating

A McGRAW-HILL PUBLICATION · FIVE DOLLARS A YEAR



Two Million Dollars for a Needle

Sewing is probably as old as mankind, but not until the year 1832 did the hole move to the point of the needle, so that machine sewing became possible. Walter Hunt of New York City had this great idea, combining with it the shuttle-carried lock-stitching thread on the underside of the fabric.

Elias Howe usually gets credit for inventing the sewing machine, but actually he worked out the idea twelve years after Hunt. Howe, you see, had the good sense to patent the idea. It brought him over two million dollars.

It's great to have an idea. It's much more wonderful to make it work. That's where we come in.

Often difficult and unusual problems are involved in operating mechanisms that depend on *pliable parts*. These must be *composed* and *designed* for continuous dependable service under a wide variety of environment and operating conditions, often in the presence of deteriorative materials or conditions.

For such critical parts, perhaps the most versatile and reliable material ever developed is SIRVENE. This is an oil-resistant elastomer (loosely called synthetic rubber) *compounded in formula* as will best meet the specific need.

SIRVENE engineers are constantly working on pliable part problems, in scores of fields. They are constantly developing new SIRVENE compounds. And when design and compositions are determined, C/R quantity production takes over, operating at laboratory-quality level.

Let SIRVENE engineers work with you from the inception of your idea for a new product. They can short-cut your work, protect you in advance against disappointment.

"Engineering with Sirvene" will be sent with our compliments if you request it. It belongs in your files.

Sirvene products include diaphragms, boots, gaskets, oil seals, washers, packings and similar molded parts.

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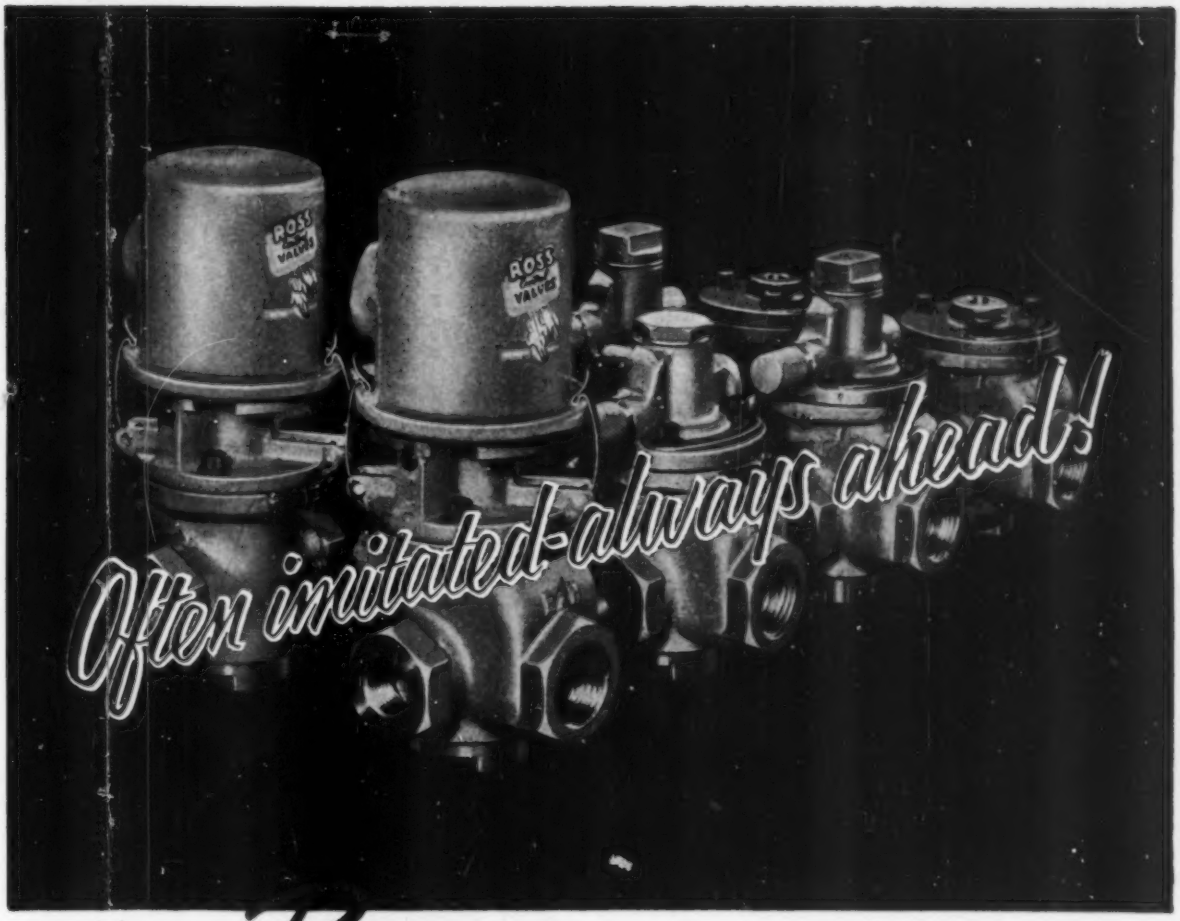

Ross In-line Valves

The reputation and performance of Ross In-line Series Valves are so outstanding that imitations are constantly being attempted. Through constant improvements, the Ross In-line Series remains the leader and the envy of the trade. Here's why—

- ☆ *Dependable*—10 to 20 million maintenance-free cycles, and many more tens of millions of life-cycles, are not uncommon.
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- ☆ *Low current consumption for solenoid models*—inrush of 1.2 amps @ 110/60.
- ☆ *Positive seal*—poppet construction; Hycar seats.
- ☆ *Easy maintenance*—only a few moving parts; can be disassembled without breaking line connections — solenoids readily accessible.
- ☆ *Many modifications*—vacuum, air, and liquid service; various pressures; available for AC or DC solenoids or air actuation with or without sequence timing; interchangeable heads.

Write for full information on the Ross In-line Series

Control

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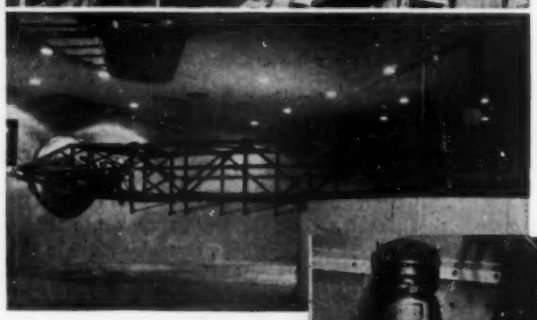
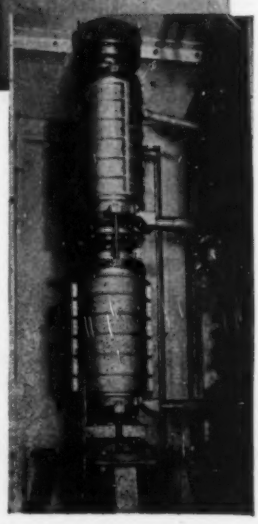
can insulate as well as conduct!

Aviation Medical Acceleration Laboratory, U. S. Naval Air Development Center, Johnsville, Pa.





Revere Sheet Copper shielding being installed on wall of the Centrifuge chamber by The Howard P. Foley Co., Electrical Contractor, 1630 Pine St., Philadelphia 3, Pa.

A view of the human centrifuge itself. This can produce positive, negative or transverse "G", through accelerations up to 40 times the force of gravity. A great many records are made of each test, including X-ray motion pictures. The subject is observed continually by television.

Upper slip-ring stack—physiological, signal and power. Here copper serves as a conductor.

Official Photographs from U. S. Navy

The fact that copper has the highest electrical conductivity of all the commercial metals not only makes it the preferred metal for carrying current, but also results in its adoption for shielding. Electrical and electro-magnetic disturbances, currents and fields cannot pass through a grounded shield of copper sheet. In this sense, then, copper becomes an insulator. It is widely used for this purpose in laboratories, to assure the accuracy of delicate instruments. A recent spectacular example of such an application is in the Aviation Medical Acceleration Laboratory of the U. S. Naval Air Development Center, Johnsville, Pa. The purpose of the Centrifuge is to test the tolerances of men and animals to the types of acceleration and deceleration produced in military aircraft and to study the physiological conditions which set limits to such tolerances. Recording instruments attached to the subjects are extremely sensitive, but thorough shielding by sheet copper makes it possible to record brain waves without amplification . . . Revere will gladly collaborate with you on scientific and industrial applications of copper and its alloys, and aluminum alloys. See the nearest Revere Sales Office.

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Product Engineering

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THIS MONTH'S COVER

The world's pioneer "Delta", Convair's supersonic entry in the military sweepstakes, undergoes final engineering check at edge of San Diego Bay, Calif., after installation of a new turbojet engine with afterburner. An auxiliary power unit provides starting power for the engine. Shortly after the pictures were taken the XF-92A was returned to Edwards Air Force Base, Muroc, Calif., for further ultra high speed flight tests over the Mojave Desert.

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Noise Filters for Electronic Computer

pack attenuation into a small space

1 ampere filter for 115/220 volt operation. Four other sizes handle 3, 5, 10 and 15 amperes respectively.

PROBLEM: **Dual line filters for operation on 115/220 volt AC or DC lines over a current range of 1 to 15 amperes.**

ANSWER: Mallory engineers designed a series of five radio noise filters to handle this requirement. They have virtually flat attenuation curves from .15 to 400 megacycles above 50 db all the way. They are hermetically sealed and meet *all JAN specifications.*

The size of each model is kept at a minimum, ranging from 4 cubic inches for the smallest to less than 9 cubic inches for the 15 ampere unit.

This is another example of the experience and skill that must go into the design of noise filters, if noise output is to be held at the required level under all operating conditions. Mallory engineers have worked in cooperation with leading manufacturers to develop all kinds of filters for motors, generators, oscillators and countless other devices. They are well equipped by experience to design the most effective filter for your needs. Why not call us today if you have a problem?

Expect more... Get more from **MALLORY**

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Highlights

When requesting further information from companies and organizations mentioned in the items below, confusion can be avoided by referring to the issue of Product Engineering in which items appear.

NONMETALLIC MATERIALS

CLARIFYING of electroplating solutions, acid and alkaline chemical manufacture and dyestuff manufacture are a few of the applications of a new felt filter.

American Felt Co., Glenville, Conn., reports the newly developed filter maintains excellent dimensional stability after continued wetting and drying cycles, good tensile, bursting and breaking strength, and good chemical resistance. The filter has been primarily developed for applications where a high degree of clarity is required.

A VINYLITE resin-based coating applied to galvanized iron has been claimed to double the service life of the iron. The Plastic Coating Corp, Houston, Texas, reports that a 1,200 hr salt spray test showed no signs of iron corrosion. The test was conducted at 92-95 F and 100 percent humidity. Similar claims are made for black iron treated with the coating.

VINYLTOLUENE, similar in behavior to styrene, is expected to be ready for commercial use by 1954. Dow Chemical Co, Midland, Mich, reports that vinyltoluene is expected to replace styrene in making synthetic rubber, paint vehicles, rubber-reinforcing resins, polyester resins, and molding powders. As a paint vehicle, vinyltoluene reacts with all the commercially important drying oils to form clear vehicles.

INSULATING TAPE made from Teflon for insulating motors, generators, tranformers, and coils is a development of the Polymer Corp., Reading, Pa. The tape is claimed to be unaffected by weather conditions, temperature fluctuations, and exposure to oil and greases. It is also chemically inert and has excellent electrical properties over a wide range of frequencies.

A RUBBER BASE PLASTIC is being used as a substitute for bronze in water meter register boxes and covers. A development of Naugatuck Chemical Div, Naugatuck, Conn., the plastic is reported to be successfully withstanding corrosive conditions and to have good dimensional stability. Another application would be in the manufacture of corrosion resistant pipe.

IN RIBBON FORM, a synthetic rubber sealer, is claimed to be non-shrinking, have a high resistance to deterioration and not to stretch or sag during application. Minnesota Mining and Manufacturing Co, Detroit, Mich, reports that the sealer is for gasketing applications or for water-tight, anti-squeak buffers. The material is not resistant to oils, gasolines, or other solvents.

METALLIC MATERIALS

FERROCHROME ALLOY containing less than 0.01 percent carbon is a development of Electro Metallurgical Co., Marietta, Ohio. Product contains about 65 percent chromium, 5 percent silicon, 5 percent silica, and iron. The alloy was developed for making very low carbon steels but its use in producing low carbon grades of stainless steels for optimum corrosion resistance may over-shadow the original development.

TINY BUT PERFECT crystals of zinc, zinc sulfide, and mercury may provide a clue to metals many times stronger than those now in use.

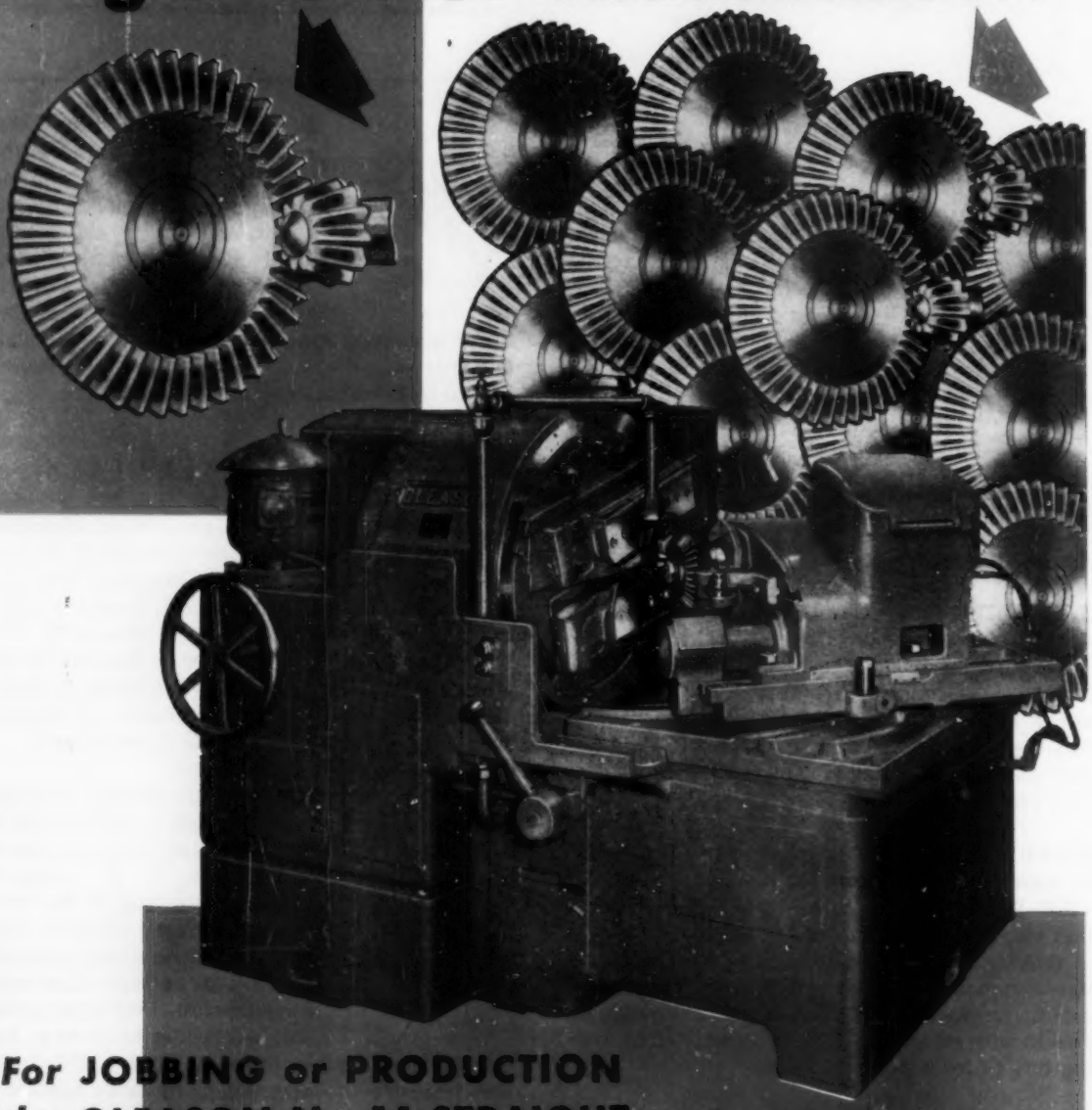
G. E. research laboratory produced the virtually perfect crystals and claim that stress tests indicate they are far stronger than ordinary crystals. Perfect crystals will according to theory, increase metal strength as much as 1,000 times and improve the magnetism of many metals.

SILICON as a component of cermets would be useful in many high temperature applications. It has been suggested by Wright Air Development Center, Ohio, that the low specific gravity of 2.3 would make silicon especially useful for turbine blades. A cermet mixture of 80 percent silicon and 20 percent titanium dioxide has been compounded and shows excellent resistance to oxidation.

A NEW MANGANESE STEEL has been added to the list of approved SAE standard steels. The SAE reports that the steel, designated type 1345, has the following composition: 0.43-0.48 C, 1.60-1.90 Mn, 0.04 P, 0.04 S, and 0.20-0.30 Si.

(continued on page 7)

Single Lots or Thousands...



For JOBBING or PRODUCTION the GLEASON No. 14 STRAIGHT BEVEL GENERATOR LEADS THE WAY

It is universal within its range . . . is easily set up and changed from one job to another . . . equipped with double track cam for roughing and finishing . . . handles gears up to 24" pitch diameter in large or small quantities.

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SELF-LUMINOUS markers are using Strontium-90 as the radioactive phosphor. Developed for the Navy by the U.S. Radium Corp, the phosphor has proved to have a longer useful life and a greater brightness value than radium and at a reduced health hazard. The Strontium markers can be manufactured in all colors except red.

HIGH STRENGTH STEELS In the tensile range of 260,000 to 280,000 psi may prove to be the answer for large aircraft and missiles. The increased strength, according to Lockheed Aircraft, would allow stronger but lighter fabrication of such components as landing gears, flooring, and other structural parts. Weight savings of 20-30 percent can be realized for increased strength values of 40 percent.

COMPONENTS

FOR OPERATION at elevated temperatures as encountered in testing aircraft turbines, reaction motors, and superchargers, a small size vibration measuring instrument has been developed. Consolidated Engineering Corporation reports the instrument can withstand 300 F temperatures continuously and 500 F for intermittent periods up to 100 hr. The unit measures one by one in. and weighs 1.3 ounces.

A PNEUMATICALLY-OPERATED control that senses engine pressures and replaces complicated electronic controls is a development of Solar Aircraft Co, San Diego, Calif. The tiny instrument, when used on a jet engine, is claimed to compute under all flight conditions exactly what the turbine discharge pressure should be and note any error. Errors are corrected by electrical signal to the engine controls. Unit is lightweight, accurate, easy to maintain and easily installed.

FACTORY MAGNETIZED a-c generator has been designed to reduce weight, simplify, and increase the reliability of aircraft and missile electrical power systems. AiResearch Mfg. Co, Los Angeles, Calif., claims the power supply requires no voltage regulator or external source of a-c or d-c voltage to shock excite the unit. The generator weighs 4 1/2 lb, has 800 w output, and provides 115/200 v, 3 phase, 400 c current.

A CENTRIFUGAL CLUTCH claimed to be of simple construction and economical to manufacture has been granted U.S. patent 2,626,033. The clutch is composed of a hub supporting two springs and clutch shoes on the drive shaft and a drum and brake lining on the driven shaft. Centrifugal force overcomes the spring force and engages the clutch shoes to the brake lining. The unit can be designed to deliver any desired torque at any predetermined speed. At very high speeds the torque is about equal to the speed.

MERCURY SWITCH giving electrical pulse action is a development of Tensitron Inc, Harvard, Mass. Switch consists of a glass tube containing a drop of mercury. Tube rotation around axis of lead wires causes mercury to roll past inside electrodes and make instantaneous contact. Suggested applications include use in timing devices, counting devices, and signaling devices.

AN ATOMIC BATTERY using a dispersion of colloidal graphite in water has been developed to a point where it delivers a small current indefinitely. Ohmart Corporation, Cincinnati, Ohio, states that the battery is primarily a metrological tool in the manufacture of new instruments for the precise measurement of radioactivity. It can also be used to measure liquid levels, specific gravity, temperature, and pressure or vacuum.

PROCESSES

METAL COATINGS that can be applied to rusted or bare unrusted metal surfaces have been developed resulting from research work done on stainless steel coatings. The coating can be applied by spray, brush, or dip and is claimed to withstand wet heat up to 180 F and dry heat to 300 F. Steelcote Mfg. Co, St. Louis, Mo, reports drying time to be 30-60 min after spraying. One gallon will cover about 600 sq feet.

AN INSULATING PROCESS that is claimed to result in the improved performance of printed circuit resistor and RC networks has been developed by Vacumet Inc, Chicago, Ill. The process seals the units in a series of humidity and atmosphere barrier layers that form a tight, single insulating shell. Load life, noise, and resistance-temperature characteristics are claimed to be improved by 15 to 25 percent.

(continued on page 9)

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extras

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The benefits of constant research:

No Parker Product is ever regarded as "perfected." Our research staff is constantly working for improvements—in simplicity, economy and effectiveness. New ideas are field tested, and passed on to Parker customers.

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The benefits of superlative field service:

The Parker technical representative who lives near you is qualified to give you immediate, expert attention. He brings the knowledge and experience of this whole organization to your plant.

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*Bonderite, Bonderlube, Parco, Parco Lubrite — Reg. U.S. Pat. Off.

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BONDERITE and BONDERLUBE aids in cold forming of metals

PARCO COMPOUND rust resistant

PARCO LUBRITE wear resistant for friction surfaces

TO COMBAT steel corrosion a new technique is under development which uses a flame-spray hand gun. Seaporcel Metal Inc, Long Island City, New York, says the gun shoots porcelain material through a acetylene torch and fuses it to steel. The equipment is an adaptation of a hand gun normally used for spraying other molten materials. Its portability allows porcelain to be sprayed on structures to large physically for factory treatment.

ARC DISSOCIATION of halides is a new process for the continuous method of reducing zirconium. Developed by National Research Corp, Cambridge, Mass, the process is commercially interesting for the production of special grades of titanium and zirconium. The process is expensive and cannot be considered satisfactory for the tonnage production of zirconium or titanium.

ULTRASONIC TOOLS vibrating at the rate of 1,620,000 times per minute will machine practically any metal or non-metal previously considered unmachinable. The new process, developed by Cavitron Equipment Corp, Long Island City, N.Y., consists of a pattern or tool shaped to any desired contour, vibrating in a tool holder at high frequency and low amplitude. Metals such as tungsten carbide, Alnico, stellite, osmium, as well as non-metallics like diamonds, rutile and quartz can be easily machined by the new vibration method.

TESTING

TO STUDY the changes in complex ceramic parts at high temperature a furnace equiped with quenching facilities is being used at the Argonne National Laboratory. With this furnace ceramic specimens can be heated to 5,000 F and then quenched in the liquid nitrogen cooled cup maintained at -320 F. These changes that have occured at high temperatures may then be observed at room temperature.

INSTANTANEOUS and continuous control and measurement of the viscosity of liquids is claimed for a new instrument. Bendix Aviation Corp., Cincinnati, Ohio reports that the instrument measures and controls by use of ultra-high-frequency sound waves. It will perform in a fraction of a second crucial tests that normally required 45 min of complex batch-taking and laboratory analysis.

A NEW INSTRUMENT designed for differential pressure measurement and transmission has been developed by the Taylor Instrument Co., Rochester, N.Y. It is a force balance transmitter intended to convert differential pressure into an equivalent 3 to 15 psi output. The unit can be used to measure the flow of fluids.

VIBRATION TESTS on phenolic foams with or without skins indicate that when they are subjected to vibration of amplitude and frequency will lose volume, shakedown, and powder. The Bureau of Ships reports that the materials must be bonded in place or firmly retained on all sides if volume loss is to be minimized. The amount of loss varies with different foam materials.

RESEARCH into the theories of lubrication, mathematical treatments of design and similar subjects are to be studied by the ASME. Also to be considered are design features of machines and how lubrication affects operators and builders of machines. Some projects already started are effect of lubrication on metals and the coordination of lubrication design data.

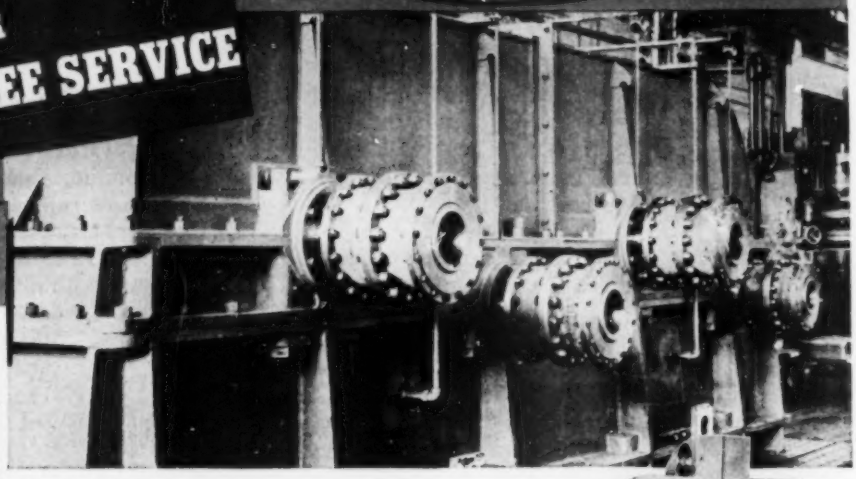
PRELIMINARY TESTS show that nylon has superior erosion and corrosion resistance when used as trim material in sea-water line valves of both globe and gate types. The Navy test reports that the nylon inserts when subjected to high-velocity sea water was found to be in excellent condition after 18 months service.

PORTABLE FREQUENCY METER has been designed for measuring operating frequency and making relative power measurements of microwave transmitters or signal sources. American Encaustic Tiling Co., Inc, Lansdale, Pa, reports the unit to be applicable for pulsed transmitters as well as to continuous wave systems. Operating range is 2,400 to 3,400 megacycles.

TENSILE AND YIELD strength values obtained in tests on heat treated aluminum alloys indicate machining practices affect these values. Harvey Machine Co, Inc, Torrance, Calif. reports that flat tensile specimens machined from extruded shapes of 75ST-6 showed a loss of 10 percent in tensile and 14 percent in yield when prepared with a dull cutter. Similar losses were noted for milled specimens of 24ST-4 where the losses were 5.6 and 20.7 percent respectively. Turned samples of an experimental Al-Zr-Mg-Cu alloy, HZMH-T6, showed comparable losses.

INDUSTRY'S CHOICE FOR TROUBLE-FREE SERVICE

Small sizes are now packaged for ease of handling and stocking



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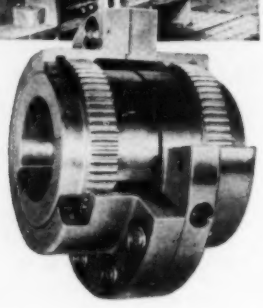
WALDRON

ADVANCED DESIGN

GEAR COUPLINGS



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First light weight, inexpensive coupling of gear type construction for nominal bores—3/8", 1/2", 5/8", 3/4". Made of unbreakable nylon. Weight 2½ ozs. Non-corrosive, non-magnetic. Requires no lubrication. Full particulars on request.

built to eliminate the usual sources of costly coupling failure

The most dependable couplings are those of gear type construction. And throughout industry the WALDRON Gear Coupling is recognized as the most advanced in design and construction of all gear couplings. Its popularity stems from its many design refinements and operating advantages which combine to insure longer service life. Features such as WALDRON all steel construction, one piece cover sleeve, crowned gear teeth, longer lining up surface, automatic lubrication, less rotating weight and others, afford extra protection against costly shutdowns for repairs or replacements. Performance records of WALDRON Gear Couplings over many years have made them first choice of the leading equipment builders. For your gear coupling—specify WALDRON.

Waldron Couplings embody more than 40 years of coupling building experience. Available in all types and sizes. Design easily adapted for special applications. Write for descriptive catalog and specific engineering data.

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Craftsman Power Lawn Mower made by Newark Stove Co., Ohio, for Sears, Roebuck and Co. Kralastic wheels molded by Ohio Plastics.

Now Kralastic's made... a wheel that's practically wear-proof!

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They're so tough they'll bounce 10 feet high from a concrete floor—unharmed! They *resist chipping, cracking,* and *corrosion.* They're impervious to water, oil, grass stains, and chemical elements in the soil.

½ the weight of aluminum ones, these wheels are quickly and easily injection molded, halves riveted together for sturdy, economical assembly. And color is *built in!*

Possibilities? Not only for implement wheels, but for drawer slides, rollers, and frictionless bearings of many kinds!

With its toughness *and* hardness over a wide temperature range, chemical and mechanical stability, clean, lasting colors, and ease of processing, Kralastic® has proved ideal for oil field pipe, safety helmets, combs, plumbing, machine housings, and hundreds of other products.

For further information on this partner to Naugatuck's MARVINOL® vinyls and VIBRIN® polyesters, write address below.

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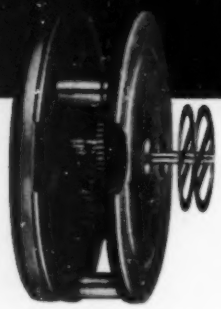
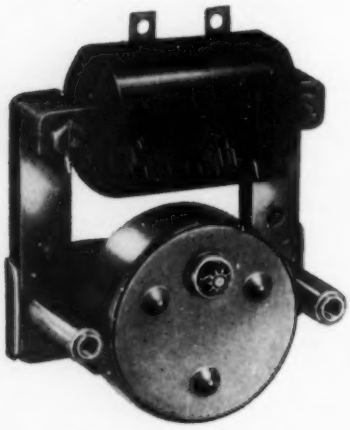
...it floats on water!



Rotor unit of H-3 motor
with cover removed



Model H-3—for radio timers,
process timers, and time switches

Telechron Synchronous Timing Motors

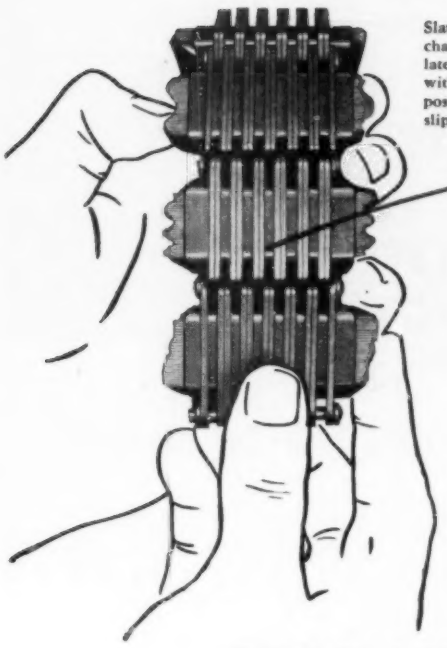
Hard, special-formula steel. Yet the rotor floats. It's so light, mere surface tension holds it up. Imagine what an advantage like this can mean to you when you specify Telechron Synchronous Timing Motors for your equipment.

There's little inertia to overcome. So Telechron motors start almost instantly—reach full speed in less than 3 cycles (1/20th sec.). Low-weight rotor virtually floats in the magnetic field. Rotor shaft rides on a film of oil—no metal-to-metal contact—giving longer life, and assuring true synchronous operation.

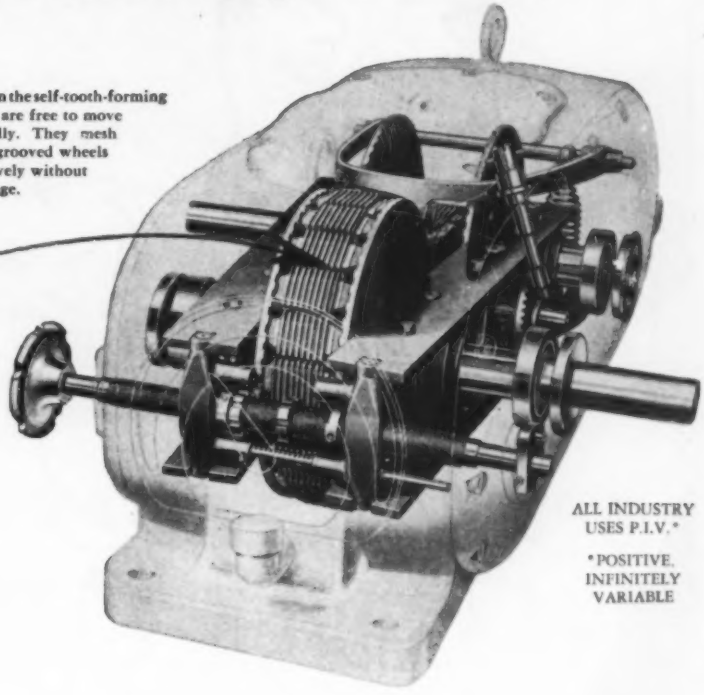
These advantages are yours in all models of Telechron Synchronous Timing Motors—no matter what the application. Let us help you select the model that will best give you the performance you are looking for. Write for complete catalog and information on our Application Engineering Service. Telechron Department, General Electric Company, 17 Homer Ave., Ashland, Mass.

Telechron®
MARK OF TIMING LEADERSHIP

Completely POSITIVE...
Completely STEPLESS
with an infinite number of speed changes



Slats in the self-tooth-forming chain are free to move laterally. They mesh with grooved wheels positively without slippage.

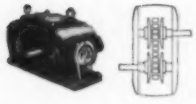


ALL INDUSTRY USES P.I.V.*

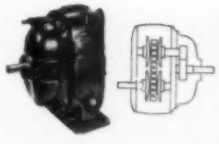
*POSITIVE, INFINITELY VARIABLE

P.I.V. Variable Speed Drive gives you exact selection from maximum to minimum speed

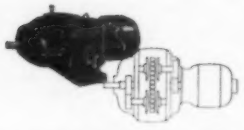
4 of 16 P.I.V types, ½ to 25 hp. — ratios to 6:1
Horizontal or Vertical Mountings



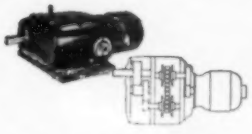
Basic Positive, Infinitely Variable Speed Drive. Compact.



P.I.V. with single reduction input or output helical gears.



Motorized P.I.V. with single reduction input and output helical gears.



Motorized P.I.V. with single reduction input and double reduction output helical gears.

ONLY Link-Belt's P.I.V. Variable Speed Drive uses self-tooth-forming chain to provide positive, stepless speed changing. The chain meshes with grooved wheels, transmits power without wasteful slip.

What's more, Link-Belt's P.I.V. changes speeds accurately under full load, delivers full-rated horsepower to your machines. That's because P.I.V. is not dependent on friction for power transmission. Its all-metal construction is not affected by atmospheric conditions.

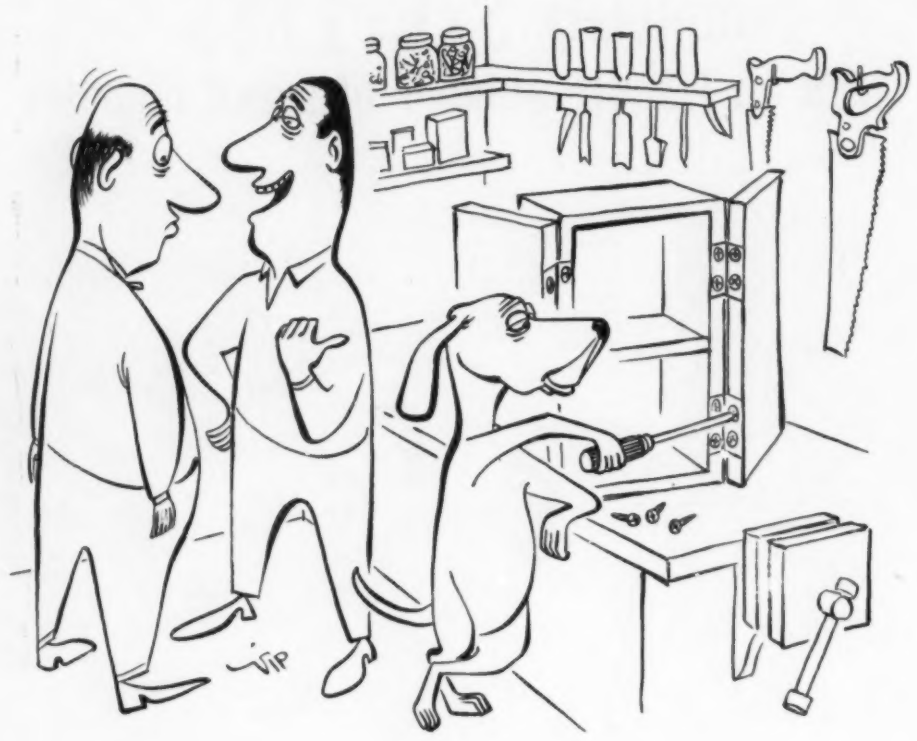
Adjustment is easy. You can obtain an infinite number of speeds with manual, electric, pneumatic or hydraulic controls . . . hold the exact speed you need at any setting.

There may be a process in your plant that requires exact, variable speed transmission. If so, it will pay you to contact your nearest Link-Belt office. They'll show you how P.I.V. can increase the flexibility and efficiency of your machines. Send for Catalog No. 2274.

LINK-BELT P.I.V. VARIABLE SPEED DRIVE

LINK-BELT COMPANY: Plants: Chicago, Indianapolis, Philadelphia, Colmar, Pa., Atlanta, Houston, Minneapolis, San Francisco, Los Angeles, Seattle, Toronto, Springs (South Africa), Sydney (Australia). Sales Offices, Factory Branch Stores and Distributors in Principal Cities. 13,110

What's Screwy? by Phillips



"Oh, he's not so smart. It's just that those Phillips Screws are so easy to drive."

PERFECTLY MATED! Only Phillips Drivers are perfectly mated to Phillips Screws. Look for the name Phillips on the shank.

EASE of driving is only *one* big advantage. Phillips Screws save time, work and money. They also add structural strength, set up tighter, resist the loosening effect of vibration. And they eliminate driver skids, damaged parts and split screw heads.

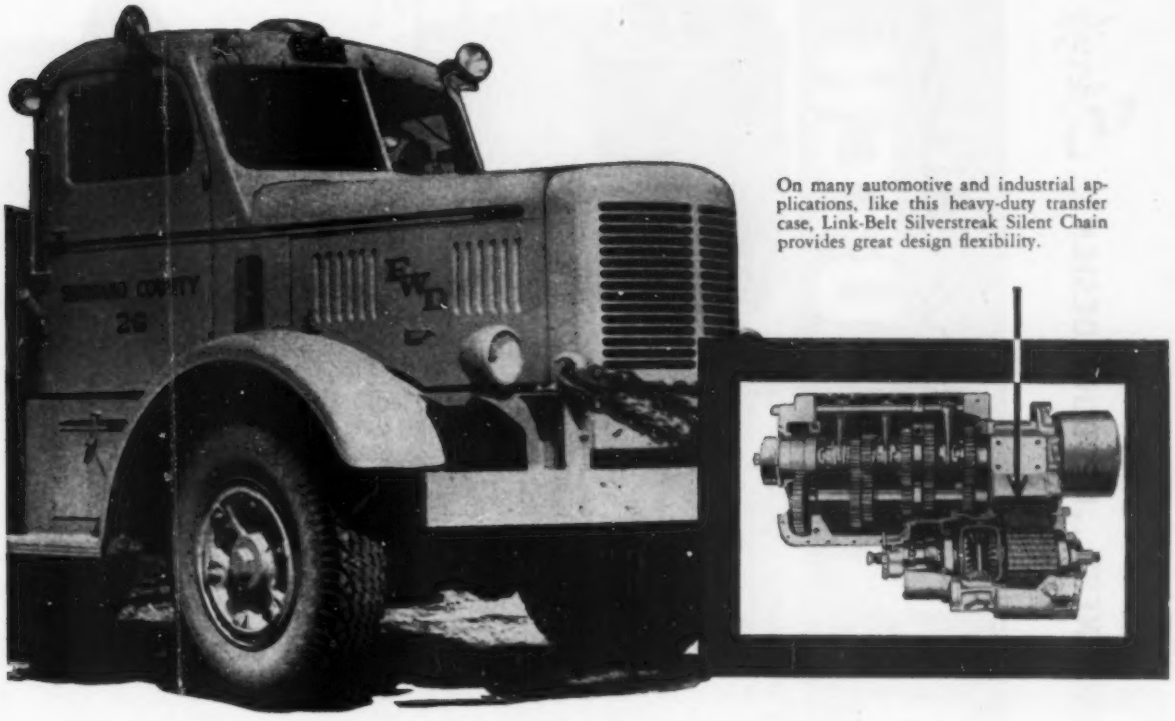
The identifying X on the cross-recessed-head identifies the x-tra quality of Phillips Screws instantly. Be sure to state "Phillips" on the specifications.

PHILLIPS *Cross-Recessed-Head* SCREWS

X marks the spot... the mark of extra quality

AMERICAN SCREW COMPANY • ATLANTIC SCREW WORKS, INC. • THE BLAKE & JOHNSON CO.
CENTRAL SCREW COMPANY • CONTINENTAL SCREW COMPANY • THE EAGLE LOCK COMPANY
ELCO TOOL AND SCREW CORPORATION • GREAT LAKES SCREW CORPORATION • THE H. M. HARPER CO.
THE LAMSON & SESSIONS COMPANY • NATIONAL LOCK COMPANY
THE NATIONAL SCREW & MANUFACTURING CO. • PARKER-KALON CORPORATION
PHEOLL MANUFACTURING CO. • ROCKFORD SCREW PRODUCTS CO. • SCOVILL MANUFACTURING CO.
SHAKEPROOF DIV. OF ILLINOIS TOOL WORKS • THE SOUTHINGTON HDWE. MFG. COMPANY
STERLING BOLT COMPANY • STRONGHOLD SCREW PRODUCTS, INC. • WALES-BEECH CORP.

TODAY'S... AND THE FUTURE'S... FINEST FASTENER



On many automotive and industrial applications, like this heavy-duty transfer case, Link-Belt Silverstreak Silent Chain provides great design flexibility.

Design for sustained high efficiency at high speeds

with LINK-BELT Silent Chain

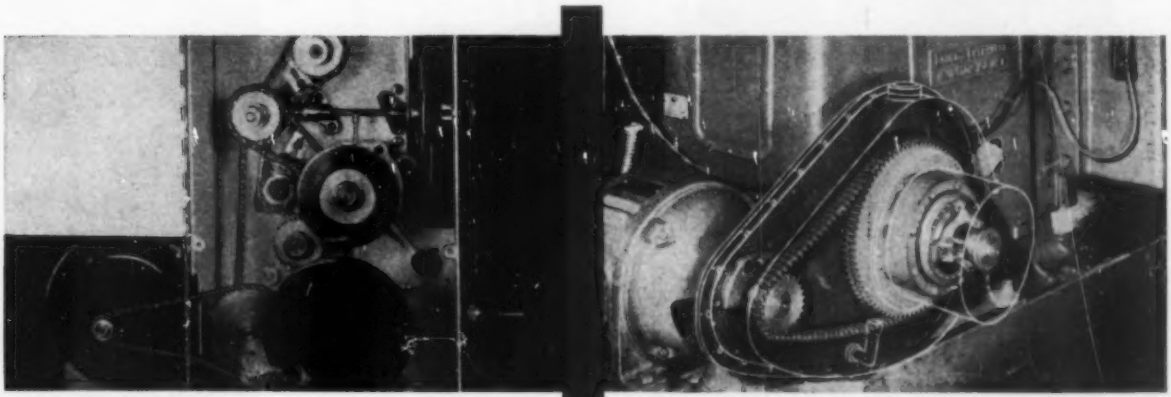
From fractional to thousands of hp--your assurance of dependable, positive transmission

LINK-BELT Silent Chain gives you a positive, no-slip, constant-speed drive. Even at high rotative and linear speeds, its better-than-98% efficiency is maintained throughout the long life of the drive. For design information on Link-Belt Silverstreak Silent Chain Drives, get in touch with the Link-Belt office near you.

LINK-BELT

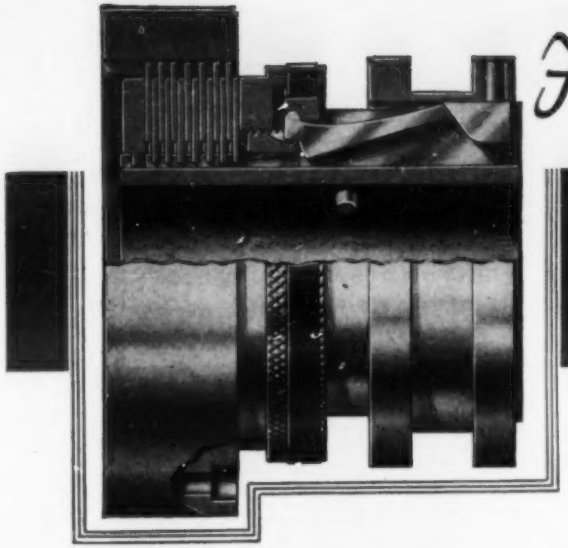
SILVERSTREAK SILENT CHAIN DRIVES

LINK-BELT COMPANY: Plants: Chicago, Indianapolis, Philadelphia, Colmar, Pa., Atlanta, Houston, Minneapolis, San Francisco, Los Angeles, Seattle, Toronto, Springs (South Africa), Sydney (Australia). Sales Offices in Principal Cities. 53.245



For constant-speed, quiet, smooth operation, Link-Belt Silent Chain is the answer. Here 3/16-in. pitch chain synchronizes sound with picture in a motion picture theater projector. Exclusive link and tooth form eliminates chordal disturbance.

Constructed entirely of steel and completely enclosed in an oil-tight casing, Link-Belt Silent Chain provides many years of high efficiency at low cost. This universal shaper is driven with Silverstreak Silent Chain (casing shown in "phantom").



For **MACHINE TOOLS... MACHINERY... PRODUCT DESIGN...** *Specify*

MAXITORQ floating disc CLUTCH

There are 2 basic types of Maxitorq clutches . . . Single and Double. Above is a cut-away view of the single type . . . the double is shown at right. Each is available in 8 capacities (wet or dry) from ¼ to 15 h.p. @ 100 r.p.m. And from 13 to 788 max. working torque ft. lbs. Pulley type, Ring type, or Cut-off Coupling Driving Cups are also available.

The Maxitorq automatic overload release clutch (up to 5 h.p.) is extremely useful for protection of machine and product against accidental overload in high speed production. Special bulletin on request.

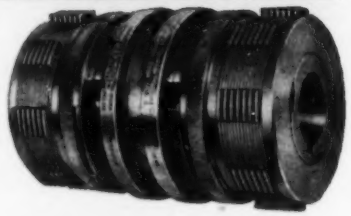
Send for Catalog No. PE-7

We hope you haven't minded turning this magazine around, but it was the only proper way to include the picture at the bottom. It clearly shows all parts of a single Maxitorq Clutch...and how easy it is to adjust it, take it apart, and assemble it...manually.

Each and every part contributes to smooth, positive, trouble-free clutch operation. The Separator Springs between each pair of inner discs keep them "floating" in neutral...preventing drag, abrasion, and heat. A Locking Plate locks all discs against the tension of the Separator Springs. The Adjusting Ring provides the means for obtaining the desired shifting pressure.

These are some of the reasons why we counted 69 machines, exhibited at the last Machine Tool Show, that were equipped with Maxitorq floating disc clutches. Send for our 50th Anniversary Catalog...and see how Maxitorq answers your problems for dependable power transmission.

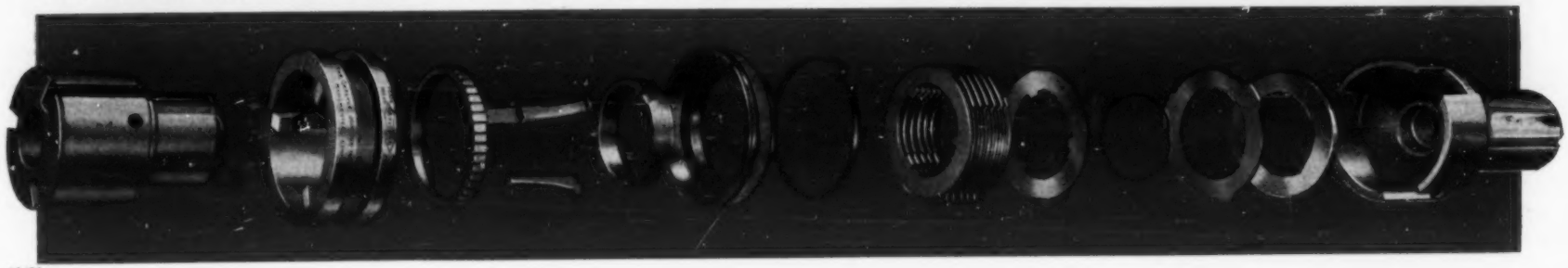
THE CARLYLE JOHNSON MACHINE CO.
MANCHESTER, CONNECTICUT



Compact, rugged construction and precise machining . . . flat, true surfaces on engaging faces of the discs . . . provide not only the exacting accuracy required in important industrial machines, but also long, profitable service life.

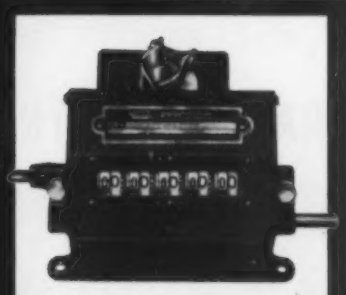
Our engineers will give you personal assistance for correct selection of the right clutch and installation for your specific requirement.

ALL ASSEMBLY, DISASSEMBLY AND ADJUSTMENTS ARE MANUAL. CLUTCHES SHIPPED ASSEMBLED ON THE BODY.



4C-283

You get what you set...



Added Evidence that—

Everyone Can Count on VEEDER-ROOT

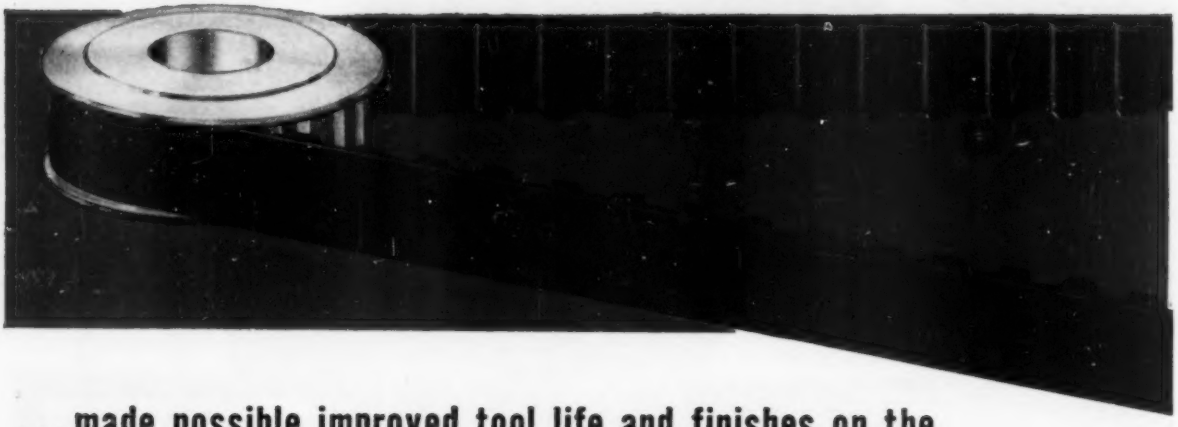
Set the predetermining wheels for any run you want. Then, when the counting wheels reach the pre-set number, an electrical contactor makes or breaks the circuit to light a light, ring a bell, or trigger a stop-motion. Yes, this V-R Predetermining Counter is an efficient variable control for *many* types of stop-motion. Short runs and over-runs are prevented on a wide range of machinery, from coil winders to textile looms. Now, figure out how *you* can use this Cost-*Count*rolling Counter. Then write:

VEEDER-ROOT INCORPORATED
"The Name That Counts"
HARTFORD 2, CONNECTICUT
Chicago 6, Ill. • New York 19, N. Y. • Greenville, S. C.
Montreal 2, Canada • Dundee, Scotland
Offices and Agents in Principal Cities

"Counts Everything on Earth"

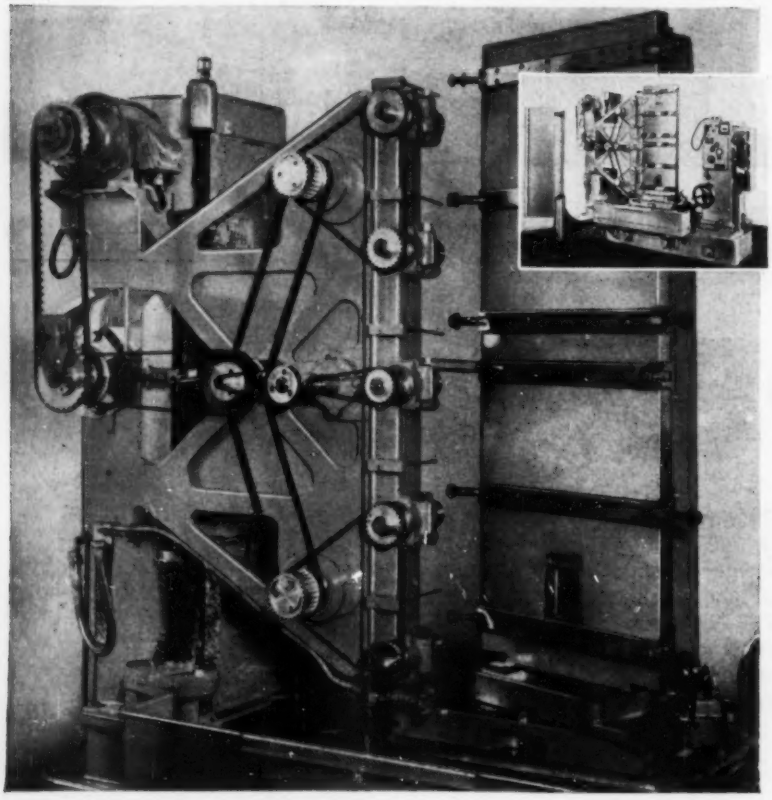
Here's How the Revolutionary

Gilmer "TIMING"®



...made possible improved tool life and finishes on the

PRATT & WHITNEY AUTOMATIC DUPLICATING MACHINE

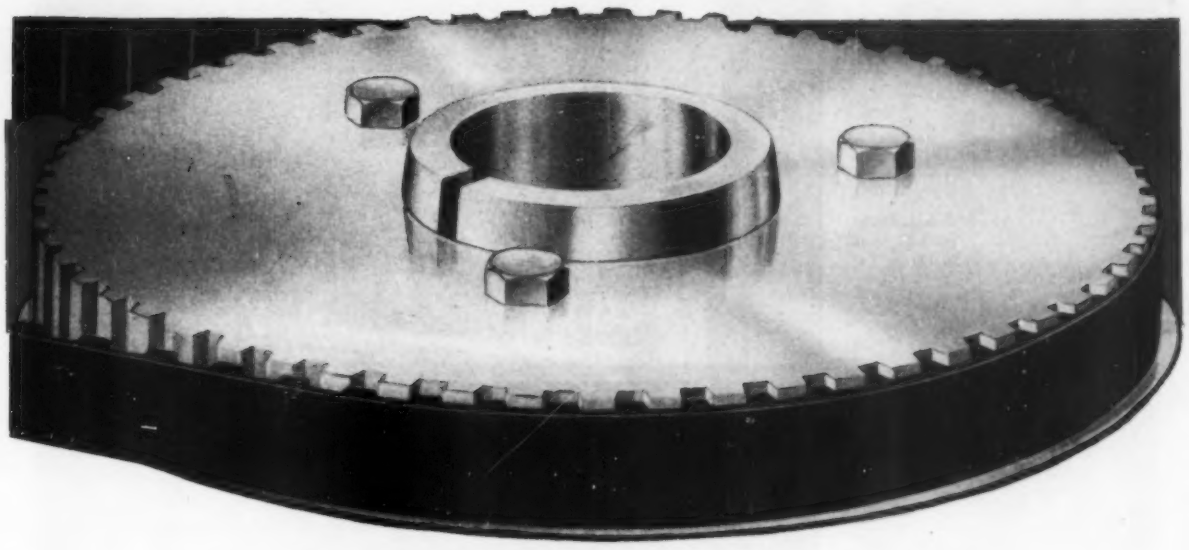


On this machine, the two upper and two lower cutter spindles, driven by Gilmer "Timing" Belt Drives, simultaneously produce four identical forging dies (such as for jet turbine blades) under control of the center *tracer spindle* which follows a hard master shape. The machine duplicates to very close tolerances, using either high-speed steel or carbide cutting tools.

Since the life of carbide tools is greatly reduced, and finish impaired, by any slippage or slowing down of the spindle drive, the round belts formerly employed not only required much larger-diameter pulleys but also produced unsatisfactory tool life, as some slippage was bound to occur. To hold this to a minimum, belts had to be installed under high initial tension, which also resulted in frequent belt breakage.

The answer to the problem proved to be a *positive* slip-proof drive requiring no initial tension, no lubrication, no large pulleys — the Gilmer "Timing" Belt Drive! Now, a total of eight "Timing" Belt Drives transmits perfectly synchronized power from the motor to the five spindles. Belt slippage and tool chatter is positively eliminated, assuring maximum life from carbide tools and uniformly high quality finishes on the work. Belt breakage is a thing of the past. Belt pulleys are considerably smaller, yet provide a speed range of 900 to 10,000 rpm required for the interchangeable use of high-speed steel and carbide cutting tools.

BELT DRIVE



Industry's New Power Transmitting Medium
SWEEPS AWAY DESIGN RESTRICTIONS

In one application after another, "Timing" Belt Drives have enabled machine designers to achieve basic engineering improvements—or to design entirely new machines—that were previously either impractical or impossible! For never before has there been a *positive drive* that combined all these desirable characteristics:

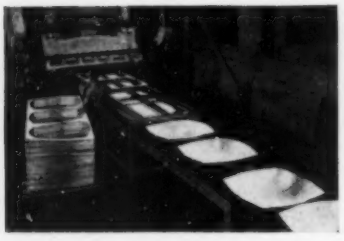
- **Requires no lubrication, no housings or lubricant guards.**
- **Maintains precise synchronization ("timing") between shafts.**
- **Provides speed ratios as high as 15 to 1 in a single step.**
- **Operates satisfactorily at speeds from inches per hour to 15,000 fpm.**
- **Permits use of very small diameter pulleys for ultra-compact drives.**
- **Has nearly 100% mechanical efficiency.**
- **Needs no initial tension. Lighter bearing loads permit lighter bearings.**
- **Does not stretch or lengthen with use; requires no take-up.**
- **Can be designed for zero backlash.**
- **Capacity ranges from 1/100 to 300 horsepower.**

These are but a few of the unique features of this amazing tooth-grip belt drive that is already in successful use on hundreds of thousands of machines. Consult your local NYB&P Distributor—or write direct—for the new "Timing" Belt brochure describing in more detail the "Timing" Belt and many interesting applications. Address: "Timing" Belt Division, New York Belting & Packing Co., Tacony, Philadelphia 35, Pa.

NYB&P — Founded 1846 — NEW YORK BELTING & PACKING CO. 1 Market St., Passaic, N. J.

America's Oldest Manufacturer of Industrial Rubber Products

From Tumblers to Trailers..



These aluminum blanks are ready to go to a manufacturer. Scrap beside press is remelted at Reynolds. Users save an average of 30% scrap loss, eliminate scrap handling expense.

Photograph shows 1700-ton hydraulic press in operation at a Reynolds plant. Work in progress is one of the largest drawn aluminum parts ever made—a one-piece 12' x 4'8" hull for an aluminum boat. This press is currently producing other drawn parts 6' in diameter.

REYNOLDS ALUMINUM

BLANKING · EMBOSSING · STAMPING · DRAWING · RIVETING · FORMING

.Get the Most From Your Designs with

ALUMINUM Press Parts from Reynolds

Shown here is a "giant's handful" of Reynolds presses along with typical aluminum parts produced on these presses by Reynolds Aluminum Fabricating Service. In *two plants alone*, out of the more than 30 Reynolds plants in 18 states, Reynolds offers 128 presses including mechanical presses from 2 to 1700 tons and hydraulic presses from 300 to 5000 tons. Reynolds can furnish press parts from simple blanks to deep drawn parts of large area; from very thin to the thickest aluminum that can be drawn.

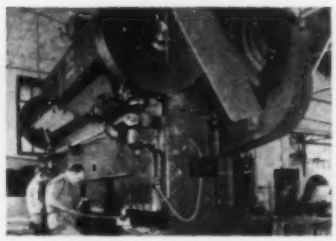
If your designs call for aluminum parts that require blanking, punching, drawing, forming, stamping, piercing, or other press operations, call on Reynolds to produce these parts to your specifications. The great variety of Reynolds specialized equipment permits you to obtain the economy of the machines best suited to your purpose without making the tremendous capital investment in equipment and added plant capacity which would otherwise be required. Reynolds quality control from mine to finished product and Reynolds experienced design and engineering service go hand in hand with these facilities to assure you the most from your designs.

For full details, call the Reynolds office listed under "Aluminum" in your classified telephone directory or write direct to Reynolds Aluminum Fabricating Service, 2051 South Ninth Street, Louisville 1, Kentucky.

Write for your free copy of the new 24-page Reynolds "Catalog of Facilities."

"Mr. Peepers" returns September 13 on NBC-TV

Here is part of a battery of medium presses in a Reynolds plant. Large, medium or small —Reynolds Aluminum Fabricating Service has presses to fit your every need.



This 12', 300-ton press brake handles thick aluminum plate. Press brakes from 22½ tons are available for your requirements by Reynolds Aluminum Fabricating Service.

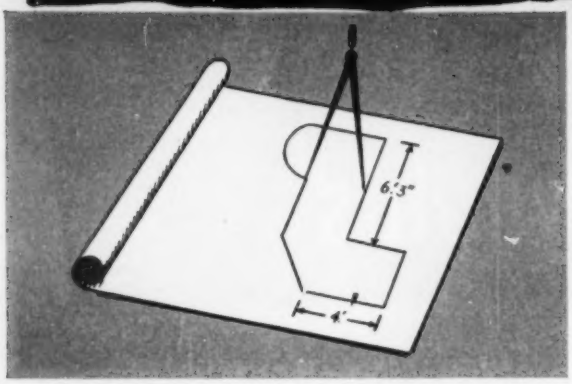
Small presses, too, are available in Reynolds plants to assure speedy delivery of high quality parts produced to your specifications by Reynolds Aluminum Fabricating Service.

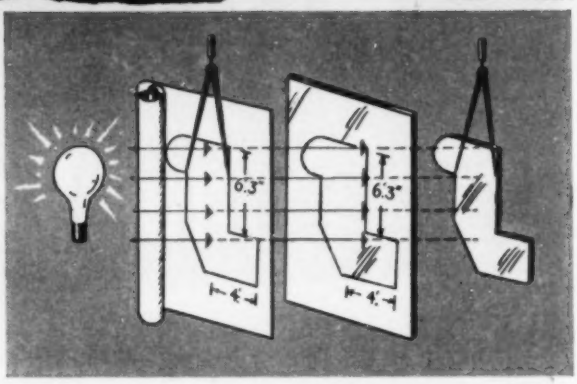
FABRICATING SERVICE

ROLL SHAPING · TUBE BENDING · WELDING · BRAZING · FINISHING

STABILENE*

GLASS TRACING CLOTH



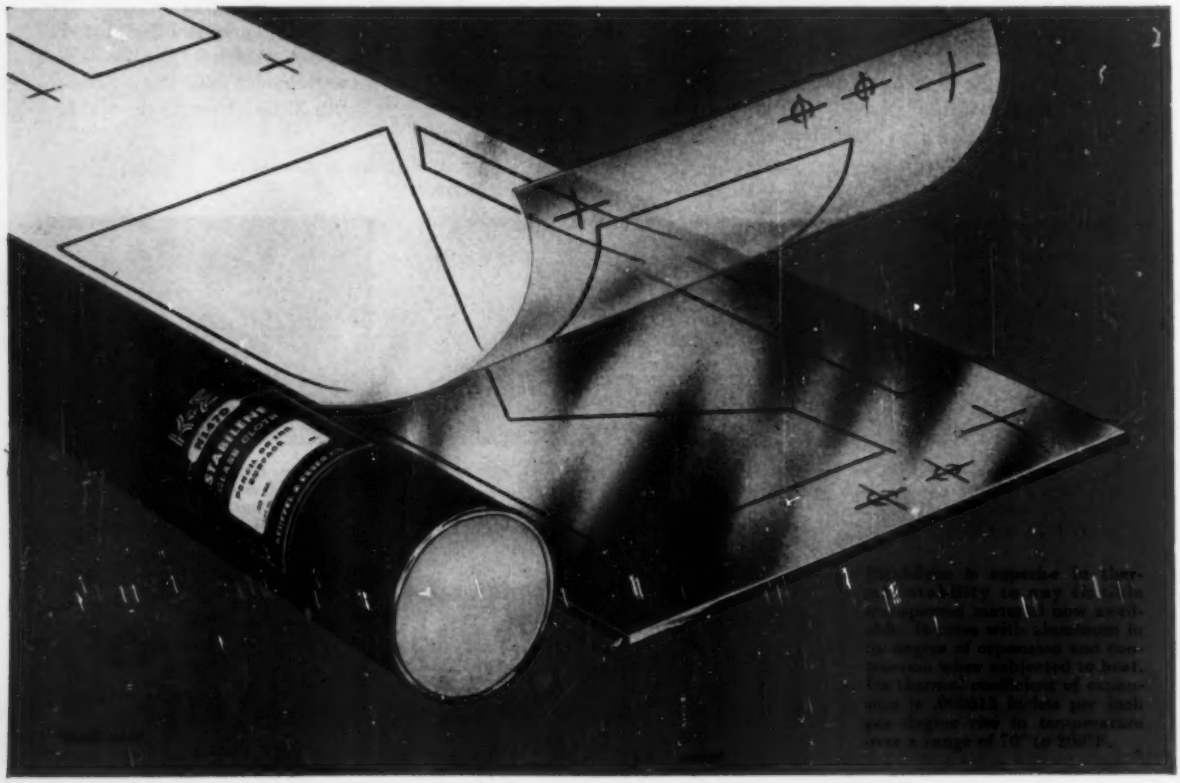


DIMENSIONALLY STABLE‡ TRACING CLOTH: Stabilene—first nationally introduced by K&E—is a new kind of tracing cloth—a *woven glass* cloth with a high degree of *transparency*. It is specially impregnated to provide an excellent drawing surface for pencil or ink.

Because Stabilene is both dimensionally stable and transparent, you can reproduce from Stabilene right on tool materials.

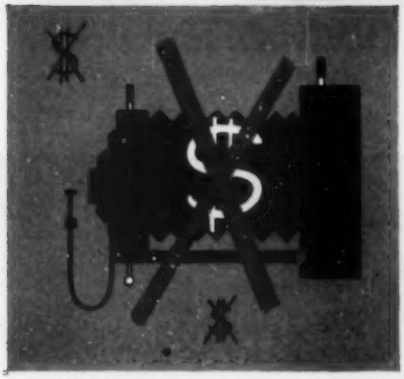
"DRAW IT *ONCE*": Tool designs are drawn *only once*—full scale on Stabilene—then reproduced by contact printing on tool material which has been sensitized with a reproduction solution.

Preliminary dimensional drawings on tracing paper or cloth are eliminated altogether. The original drawings on dimensionally stable Stabilene are the *only* drawings required from drafting room through tool production.



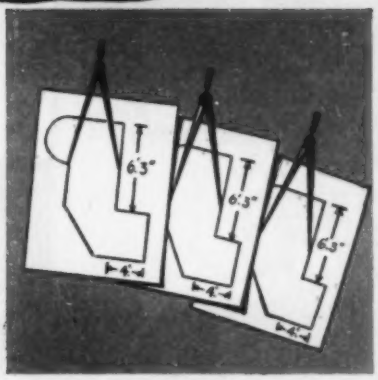
CUT COSTS!

The Right Angle



REVOLUTIONIZES PRODUCTION AND COSTS: Eliminates the need for shop layouts, camera photography, hand-scribing, and other methods calling for expensive equipment and highly trained personnel.

If a template is damaged or extra templates are needed new ones can be made from the original Stabilene drawing . . . quickly, easily, and inexpensively.



"DUPLICATE ORIGINALS" FROM STABILENE: Stabilene, itself sensitized for reproduction, can be used for dimensionally stable "duplicate originals." Such reproductions made on Stabilene are easily shipped to sub-contractors in lightweight rolls. "Duplicate originals" can also be used as the basis for design changes, new drawings, or composite drawings.

Stabilene has cut costs for the aircraft industry, for instance, by eliminating many laborious steps once essential to the production of jigs, fixtures and dies, and other tools.

Stabilene is used by oil and utility companies, as well as by government departments for mapping and plane table work. Stabilene's dimensional stability is of vital importance in all these functions. For optical comparator work, the dimensional stability of Stabilene Glass Tracing Cloth makes it as accurate as the glass screen itself. Its transparency, too, is an essential feature for this work.

Stabilene has done much for others . . . think about what it might do for you . . . in cutting costs and speeding production.

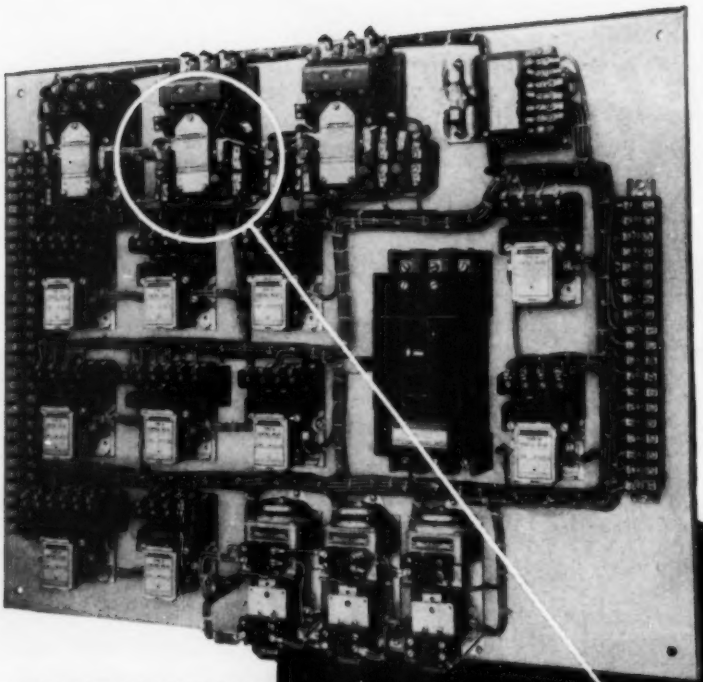
We will gladly advise you about the application of Stabilene and help you get started. K&E can also make Stabilene reproductions for you. Write Keuffel & Esser Co., Hoboken, N. J. or ask your nearest K&E Branch or Distributor.

Save time, trouble and eyesight with a K&E PARAGON† Drafting Machine. You control your calibrated straight edge with a light touch of one hand, for parallel lines and lines at any angle.

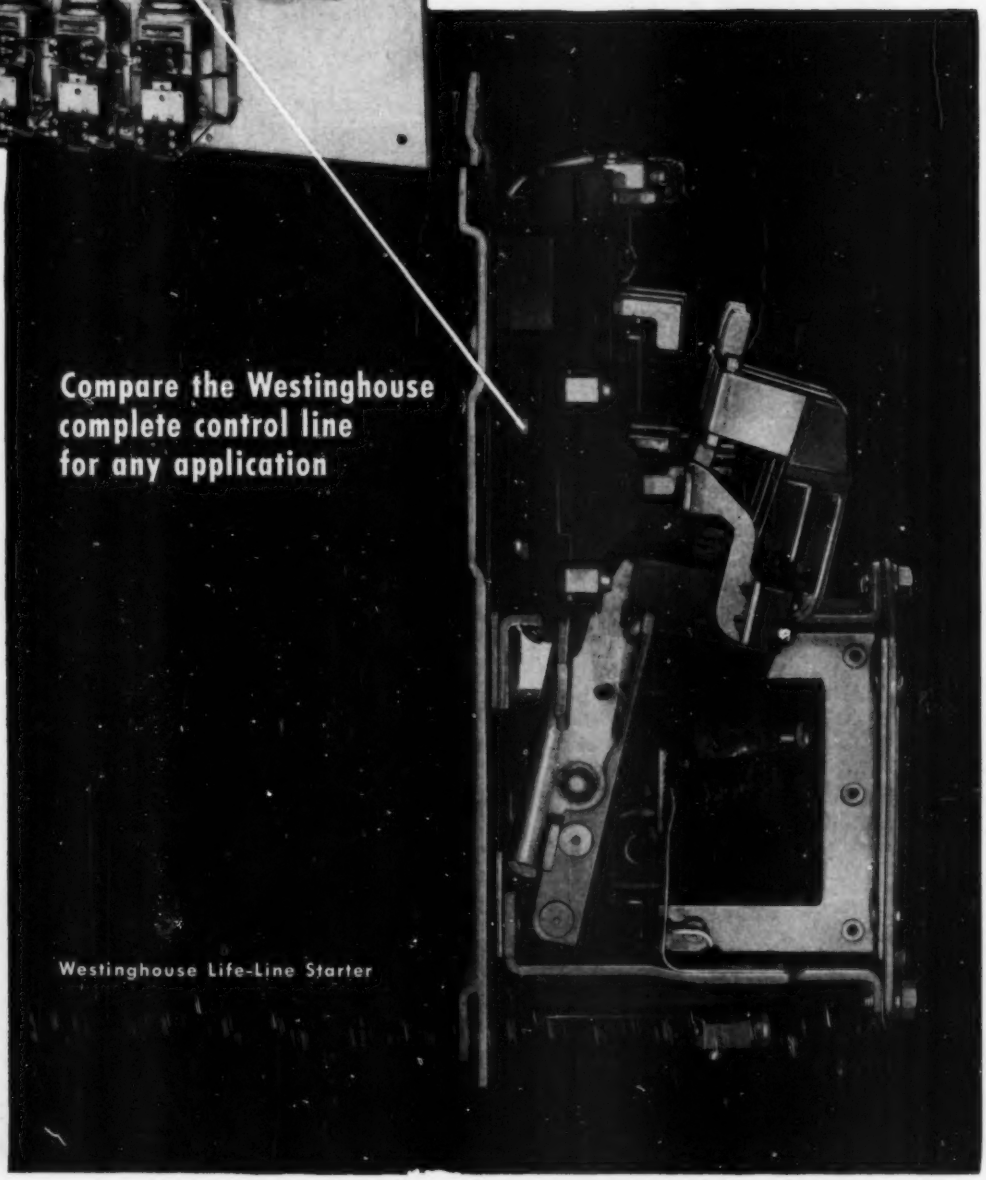
Make your lettering letter-perfect and save wear and tear on your nerves by using a LEROY† lettering outfit. Template grooves guide your pen so the finished result looks like printers' type, and the whole process is relaxing. There's a wide choice of sizes, styles and symbols.

†TRADE MARKS ®

K+E

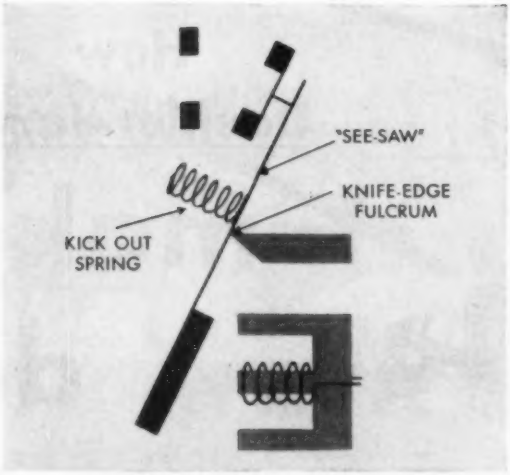


Typical special control panel with all Westinghouse components.



Compare...

Simple knife-edge principle means longer life in Westinghouse Life-Line starters



Contact assembly is pulled against a stationary magnet—pivots on a frictionless knife-edge fulcrum. 13 years of field and laboratory testing proved the superiority of this design.

This attractive, Bonderized, general-purpose enclosure is one of many NEMA type enclosures for any industrial application. A complete line of open Life-Line Starters are available for use in machine cavities or panels.

Longer wear in the starters you buy means better performance of the machines you sell. That's why it pays to compare Life-Line Starters—for unfailing, trouble-free service over millions of operations.

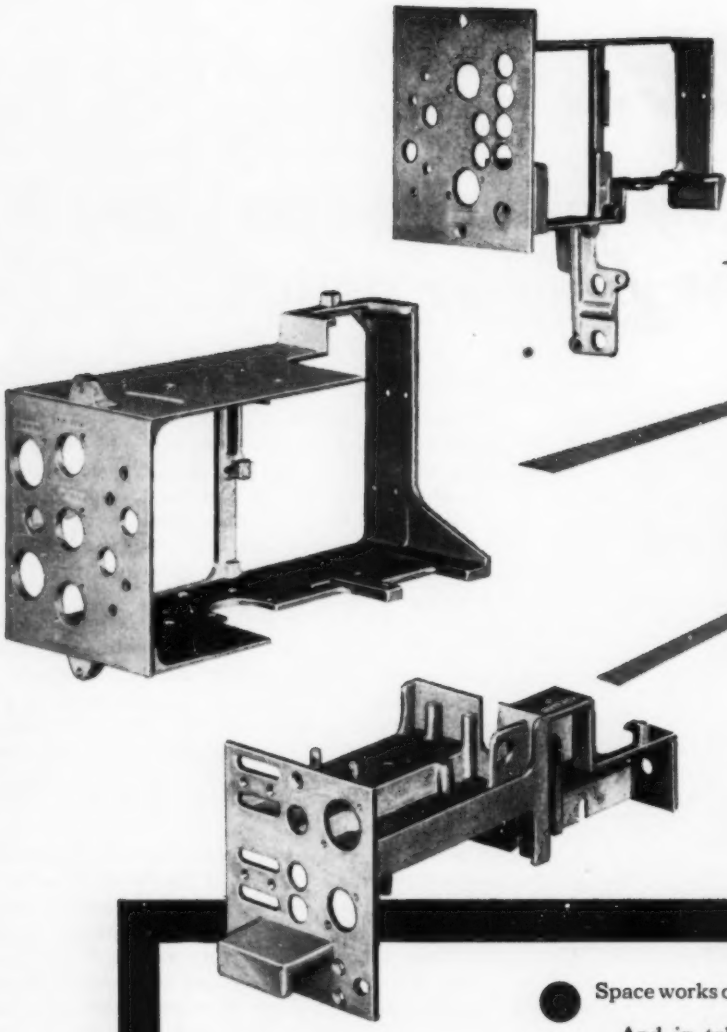
Life-Line Starter has only one moving element—a "seesaw" balanced on a special knife-edge bearing. A positive kickout spring provides the contact-opening force.

This exclusive Westinghouse design eliminates two undesirable features of conventional starters: sliding members and gravity action. Life-Line's moving element is friction free—cannot stick or jam—needs no lubricating—is self-aligning. And Life-Line Starters never operate falsely due to vibration, stress or accidental impact. You can count on dependable performance on any type of machine—under any operating condition.

Simplified design, longer life, greater dependability—these are fundamentals of the Westinghouse complete control line—starters, relays, timers, transformers, terminal blocks, oil-tight pushbutton stations. On your machines, in your panels, Westinghouse controls mean more profit and customer satisfaction.

For complete information and application assistance on Life-Line Starters and other Westinghouse control equipment, call your Westinghouse Representative, or write Westinghouse Electric Corporation, Box 868, Pittsburgh 30, Pa. J-30152

YOU CAN BE SURE...IF IT'S Westinghouse



How Doehler-Jarvis make do

These Three Doehler-Jarvis Chassis Castings Nest Together . . .

form the framework for a voice channel unit (mid-ad), one of 12 housed in the N-1 Carrier Terminal shown at extreme right. The Terminal also contains 3 other sub-assemblies, different from the one shown, to mount circuits common to all 12 voice channels. In all, 39 Doehler-Jarvis die castings are used in the Terminal. Notice the complexity of the coring and the use of chassis sections to provide shielding.

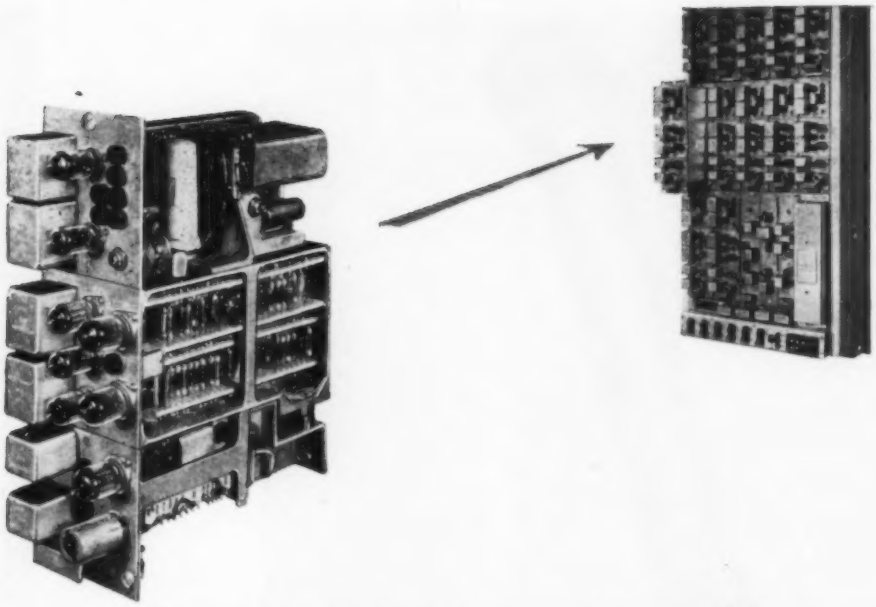
Space works overtime in America's telephone system.

And in telephone offices, the equipment which sends and receives multi-voice signals must be packed in... like sardines in a can.

That's the type of space conservation problem which faced Bell Laboratories' engineers, when they were told to come up with designs for the N-1 Carrier Terminal shown.

Earlier forms of similar equipment had to be simplified, then packaged in 1/6 the space to mount on standard racks. After considering several ways to do the job, it was decided to use nesting die cast aluminum chassis units. Die castings would provide dimensional accuracy, rigidity, light weight, good finish... and they could be formed in intricate section.

For help in establishing the most practical designs,



helped Bell Telephone Laboratories

one unit of space the work of six

Bell Laboratories called in Doehler-Jarvis right at the start. (A good thing for you to do, too.)

From then on engineers of both organizations worked as a team, pooling experience and facilities. Together, they designed die cast units which took into full account electronic requirements and used die castings to their best advantage. By so doing, much costly redesign was avoided . . . and when it came to mass production and assembly, there wasn't a hitch. Today, Doehler-Jarvis is producing the chassis units for not only the N-1 Terminal but another type of these multi-voice systems.

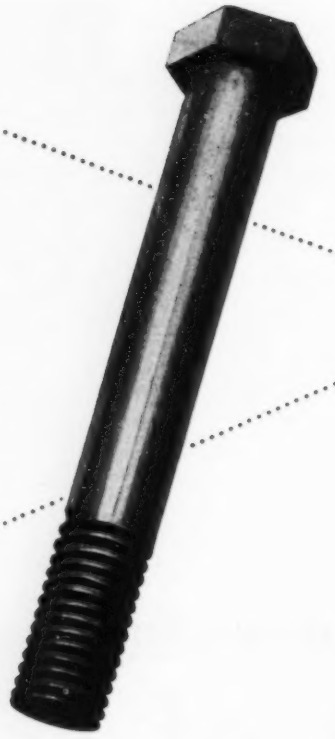
How About Cost? "We estimate," say Bell Laboratories' engineers, "that we recovered our die costs on the first hundred N Carrier systems by the savings over other methods of framework fabrication. This is one month's production at the present rate."

Ask Doehler-Jarvis to help you reach your design goals through skillful application of die casting. Die castings can help solve many other problems beside space conservation.

Whatever your need . . . it pays to call in Doehler-Jarvis, the company which pioneered die casting more than a half century ago. Nine plants in five cities to serve you.

Doehler-Jarvis Division
of
National Lead Company
General Offices: Toledo 1, Ohio

*Reg. U. S. Pat. Off.



You wouldn't hold a bolt to ± 0.0002 in.

Why pay for unneeded precision in ball bearings?

In many applications where speeds and loads are moderate, you don't need a precision bearing. When this is the case, Schatz "Commercial" Ball Bearings can cut your costs by as much as 85%—*without any sacrifice in operating efficiency.*

Why are savings like this possible? Because "Commercial" Ball Bearings are designed to wider tolerances than precision bearings...because they are available unground, partially-ground, or fully-ground. And, because, in almost all cases, cages are not used.

If you have an application where speeds and loads are moderate, it will pay you to look into Schatz "Commercial" Ball Bearings. To learn how you may save, write for literature described below.

THE SCHATZ MANUFACTURING COMPANY
6758 Fairview Avenue, Poughkeepsie, New York

Schatz "Commercial" Bearings used on these products

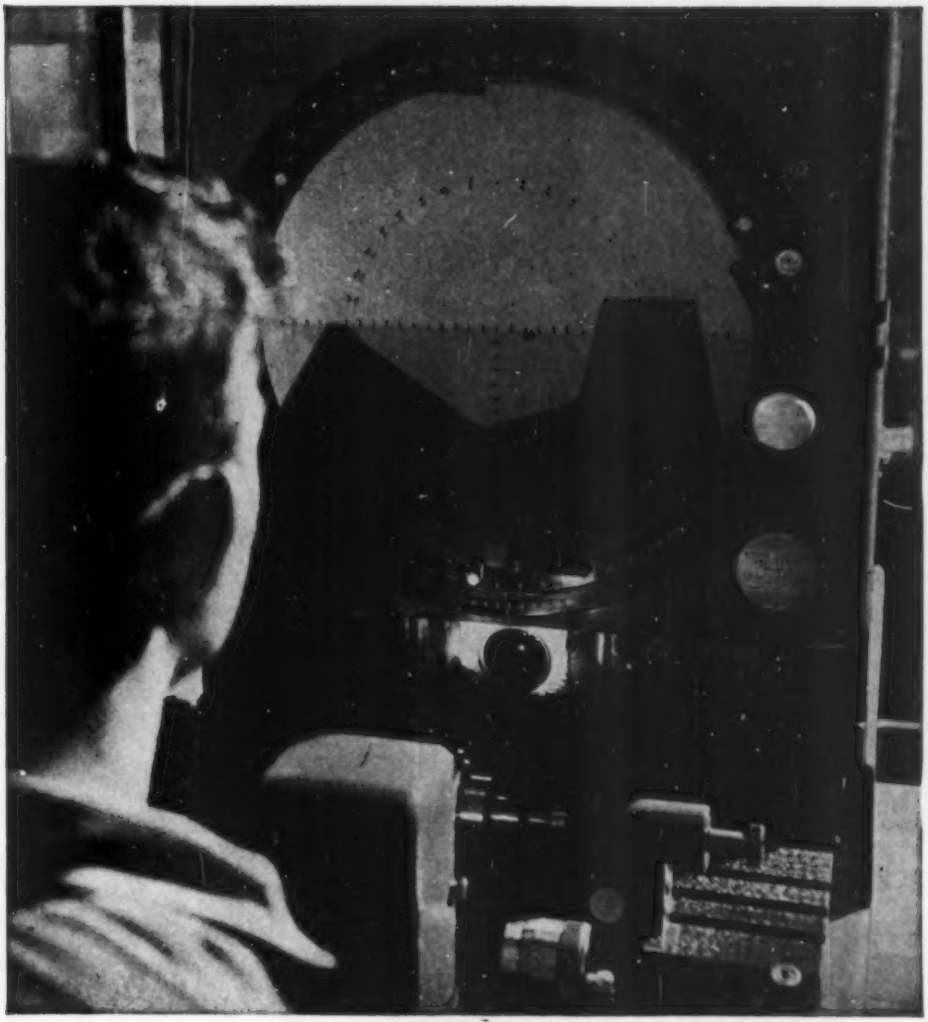
Dishwashers • Outboard motors
Automobile steering mechanisms
Elevators • Box machinery
Office equipment
Flexible shafts • Lawn mowers
Masonry cutting equipment
Textile machinery • Farm equipment
Laundry equipment

What about your product?

The oldest, largest manufacturer of "Commercial" ball bearings

SCHATZ
"Commercial"
BALL BEARINGS

Technical literature available:
Schatz Catalog 11 contains drawings and specifications of Schatz Ball Bearings.
Technical Bulletin tells how to determine proper type and size "Commercial" Ball Bearing for various speeds and loads.
Nylon Bearing Parts discusses advantages of nylon parts in "Commercial" bearings.



Front Row at the Raceway

TAKING STEPS to assure that the sides of bearing rings will be parallel to each other, and to the ball track, begins with proper tooling.

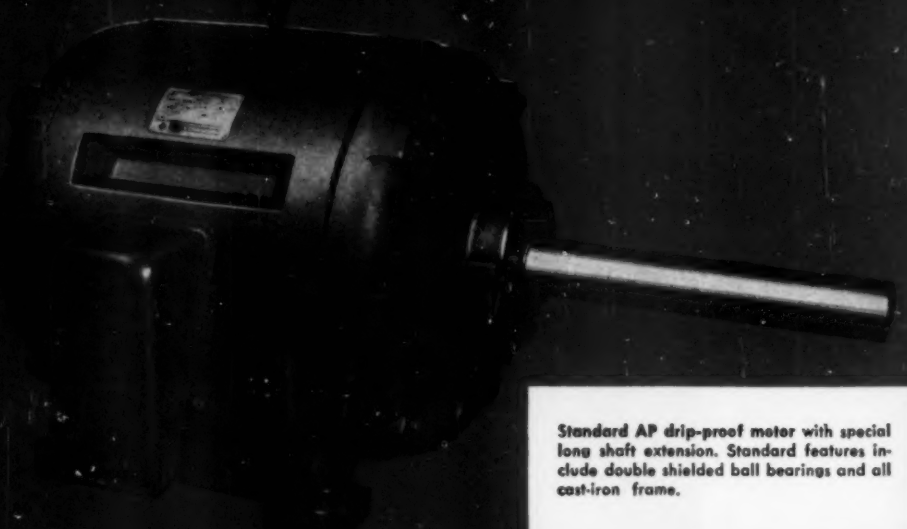
That's why Federal spares no pains to gage the form tools used to produce its ball bearings. Here, for example, a technician inspects contours in an optical comparator; a prism of light projects the tool outline, 20 times enlarged, onto the gridded screen. By careful inspection, he can often hold difficult tolerances to 0.0001 in. or finer.

It's by this thinking in terms of perfection, not time, that Federal produces quiet, friction-free ball bearings. Such precautions are your assurance of top performance from *every* Federal Ball Bearing.
The Federal Bearings Co., Inc., Poughkeepsie, N. Y.

Federal
Ball Bearings

One of America's Leading Ball Bearing Manufacturers

Modified Standard Motor—



Standard AP drip-proof motor with special long shaft extension. Standard features include double shielded ball bearings and all cast-iron frame.

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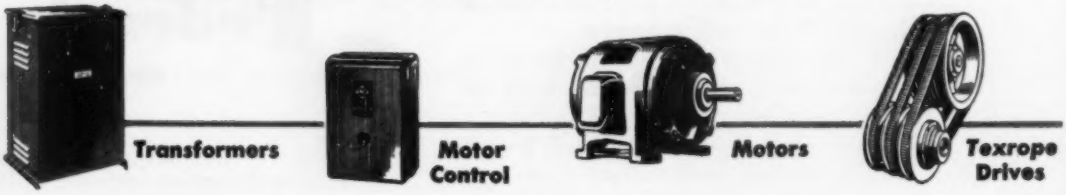
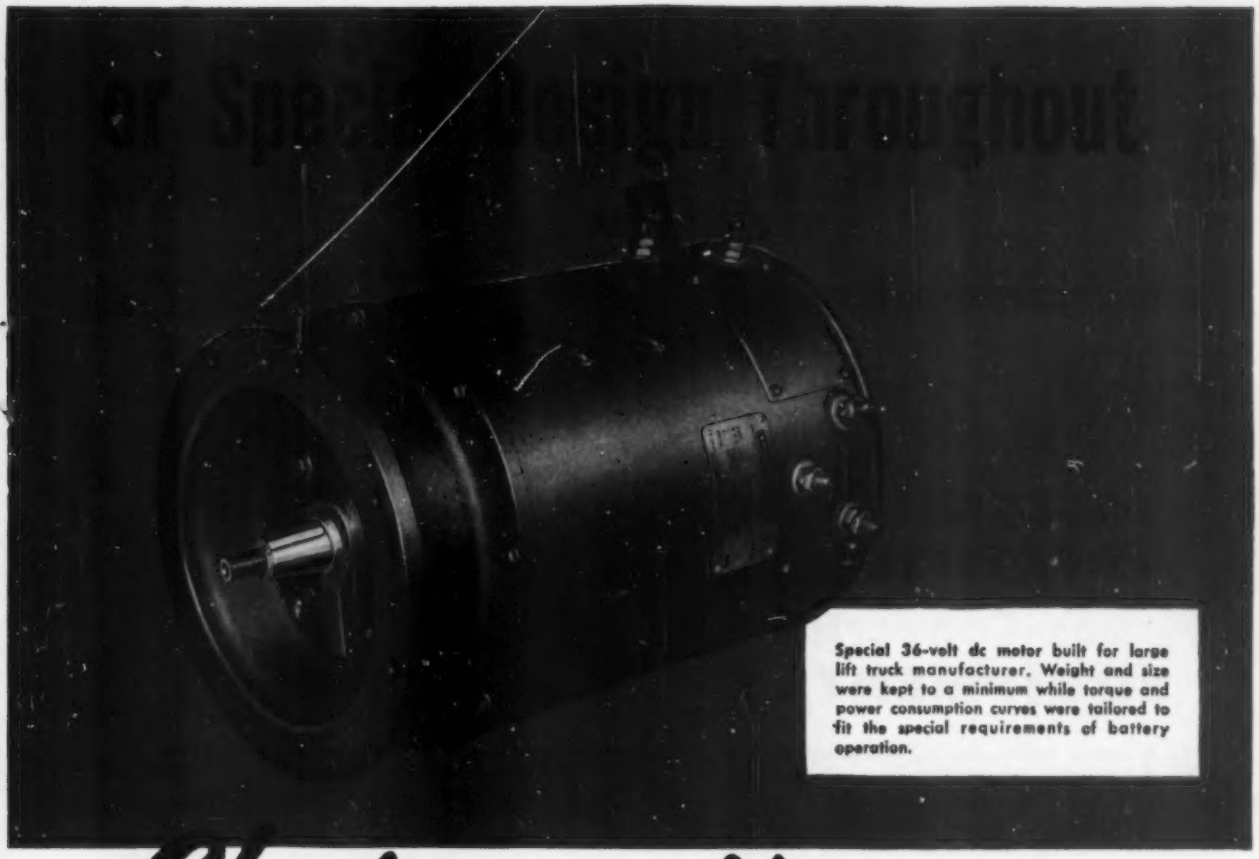
COMPLETE SERVICE *from power line to machine*





Special 36-volt dc motor built for large lift truck manufacturer. Weight and size were kept to a minimum while torque and power consumption curves were tailored to fit the special requirements of battery operation.

Chalmers Help ON YOUR SPECIAL MOTOR PROBLEMS

BRING YOUR SPECIAL MOTOR PROBLEMS TO ALLIS-CHALMERS. Whether your problem involves space restrictions, electrical characteristics, enclosures, performance curves or any other design feature, Allis-Chalmers engineers will help you. They know the problems of the design engineer intimately because Allis-Chalmers designs and manufactures control, drives and many types of machines in its own plants.

Modern Testing Facilities — You can be sure that an Allis-Chalmers special motor will deliver the performance designed into it. Every special design is tested in one of the most modern motor laboratories in the industry. Complete tests are run on both pilot and production units.

Nation-wide Service — Almost 100 Allis-Chalmers Certified Service Shops, located in every major industrial area in the country, are equipped to give prompt, factory approved service on any Allis-Chalmers motor you put on your equipment. In cases where special motors are used, the Certified Service Shop has access to factory data and uses only factory approved parts and procedures. You don't need to worry about service when you use an Allis-Chalmers special motor.

When your machines require special motors, call in the Allis-Chalmers representative early in the planning stage. He may be able to make valuable suggestions. Call your nearby Allis-Chalmers District Office or write Allis-Chalmers, Milwaukee 1, Wisconsin. A-3966

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Save Money, Maintenance and Man-hours!

GET YOUR DC FROM AC

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SELENIUM RECTIFIER Power-Converting EQUIPMENTS

NO costly, bulky, moving equipment to buy ... no expendable parts to replace frequently ... virtually no maintenance! No wonder Federal's compact, rugged, always-dependable Selenium Rectifier Equipments are the growing answer to DC output requirements ... for industrial power, battery charging and hundreds of other DC applications.

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IF the DC output you need is not listed in Federal's line of standard power supply equipment, Federal will design and build to meet your specific requirements.

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POWER SUPPLIES—
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Chucks, brakes, clutches, screens, separators, drums, pulleys, lifting magnets, relays, circuit-breakers, solenoids, DC motors—these are only a few of the wide variety of applications now being successfully served by Federal Power Supplies.

Federal's FTR-3152-AS
Typical of the many standard types ready for shipment
Rated:
115/230 volts, 4.4/2.2 amps.
AC Input: 220/440 volts
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Battery Charging Equipments using Federal Selenium Rectifiers have received wide acclaim from all fields for their high efficiency, long life and minimum maintenance. Federal-engineered equipments are designed to give maximum battery life.

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MAGNETIC AMPLIFIERS
Powered by Federal Selenium Rectifiers

Presently used in a wide range of successful applications for industry and the Armed Forces, such as:

- Voltage Control
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- Temperature Control
- Photoelectric Control
- Counting
- Automatic Regulation

Federal Selenium Rectifiers, in partnership with the right magnetic components, provide Magnetic Amplifiers outstanding for:

Stability • Accuracy • Long Life
High Gain • Fast Response • Low-cost Operation

Seasoned designers and students alike find it easy to be dazzled by the glamour fabricating processes possible with aluminum and magnesium. Forging presses, big as a house. Extruded shapes 34 inches wide. Impact presses whacking out aluminum parts from slugs in 1/500th of a second.

Yet the fact remains that about ¼ of the aluminum fabricated is cast. And it is also a fact that the light metals are cast by every possible process—sand, die, permanent mold, plaster, investment, centrifugal.

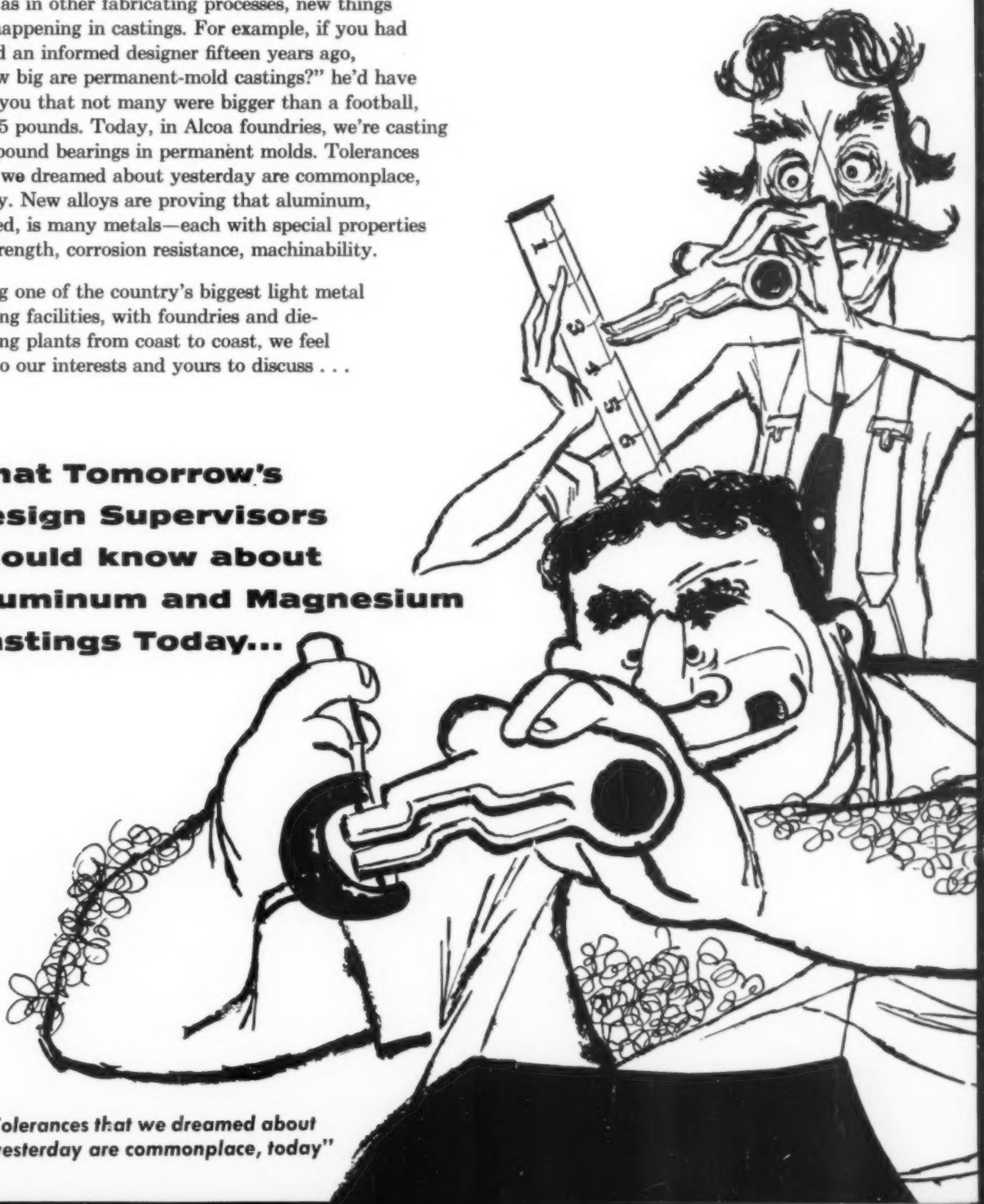
Just as in other fabricating processes, new things are happening in castings. For example, if you had asked an informed designer fifteen years ago, "How big are permanent-mold castings?" he'd have told you that not many were bigger than a football, 1 to 5 pounds. Today, in Alcoa foundries, we're casting 800-pound bearings in permanent molds. Tolerances that we dreamed about yesterday are commonplace, today. New alloys are proving that aluminum, indeed, is many metals—each with special properties of strength, corrosion resistance, machinability.

Being one of the country's biggest light metal casting facilities, with foundries and die-casting plants from coast to coast, we feel it's to our interests and yours to discuss . . .

ALCOA SECTION

World's Largest Light Metal Casting Facilities

What Tomorrow's Design Supervisors should know about Aluminum and Magnesium Castings Today...



". . . Tolerances that we dreamed about yesterday are commonplace, today"

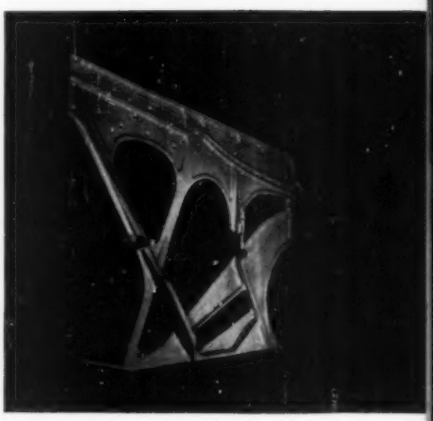
The Casting Processes

SAND CASTING...

most versatile of the casting methods, can be used to make parts weighing from a few ounces up to 7,000 pounds and more. Sand casting is ideal for producing small quantities of identical castings. It is a good way to make exceptionally large castings or ones that are very intricate. Designs that are suitable for high-speed molding equipment can be duplicated in large quantities at low cost.

Sections as thin as ⅛ inch are practical with sand castings. Tolerances of 1/32 of an inch are practical for the smaller castings. Smooth surfaces are possible by using fine sand. But here again, it is limited to smaller castings. The larger castings require coarser sand to allow gases to escape. However, you can be sure that aluminum and magnesium sand castings have smoother as-cast surfaces than those of heavy metals.

SAND-CAST PIANO PLATES. The lightness of aluminum makes it an ideal material for piano plates. Not only does the manufacturer save money on shipment, and handling, but the user finds the piano easier to move about. The average aluminum plate weighs 110 pounds less than its cast iron counterpart. Since the combined load of the piano strings totals 18 tons, these castings must be strong and sound. Finishing may be eliminated entirely. The approximately 200 pins that hold the strings are cast as inserts in the plate, thus saving costly machine operations.



"... Not only does the manufacturer save money on shipment, and handling"

PERMANENT-MOLD CASTINGS...

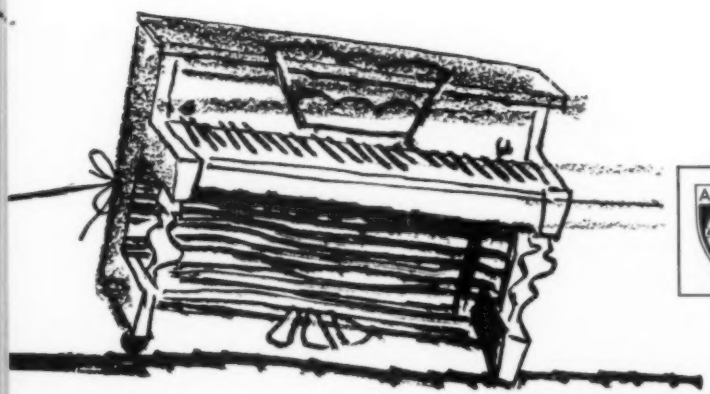
have really come of age. New mold-making techniques and metallurgical developments in our foundries have helped us bring permanent-mold castings to a size unheard of a few short years ago. In any normal day in Alcoa foundries, you'll see pistons for diesel engines being cast in permanent molds. They weigh up to 250 pounds. Compressor cases for jet engines weigh 150 pounds. Roll-neck bearings for steel mills, three feet high and three feet wide, weighing 800 pounds.

The surfaces of even the biggest castings are smooth and clean. Tolerances are usually figured at 1/64 inch plus .002 inch for each inch of length. However, we've made permanent-mold castings with tolerances of 1/32 inch in five feet.

Permanent-mold castings are usually used for long production runs.

You can figure that permanent-mold castings are substantially stronger than sand castings, due to their metallurgical superiority. Frequently, the sand and permanent-mold processes are combined. This process, called semipermanent-mold casting, utilizes a sand core.

PERMANENT-MOLD CAST BEARINGS
These bearings are used on the roll necks of steel mills where the extreme pressures require a good bearing material. These castings weigh 800 pounds apiece, are three feet high and thirty inches in diameter. The wall thickness is 4 inches. Even in permanent-mold castings of this size, the surfaces are smooth and clean as cast.

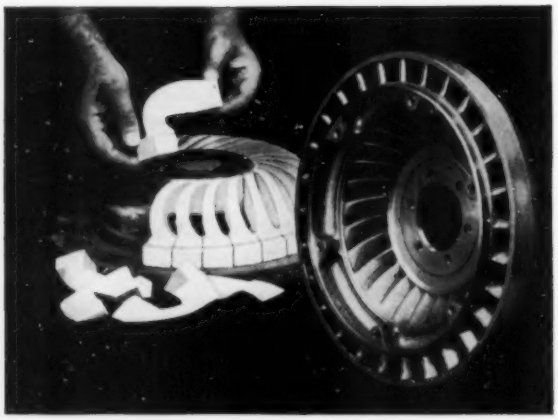


PLASTER CASTING...

is a precision process. Like the permanent-mold process, plaster casting used to be confined to small parts. Now castings weighing hundreds of pounds are being made in Alcoa foundries by the plaster process.

Plaster casting combines the intricacy of sand casting with the fine surface finish and dimensional accuracy of permanent mold. Tolerances of .005 inch per inch are not unusual. Molding costs are somewhat higher than for sand castings, but savings in subsequent machining often dictate the plaster process. When set up on a production basis, plaster casting often competes with permanent-mold and sand casting in cost.

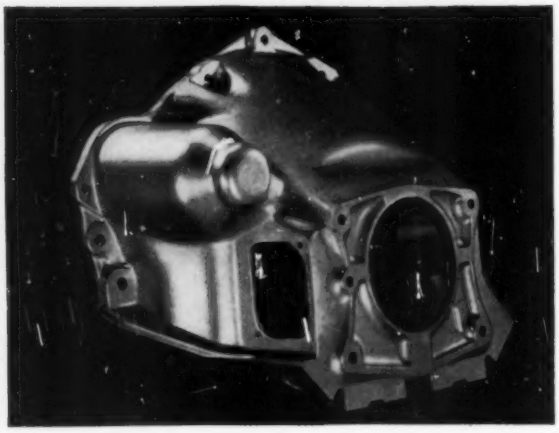
With the plaster process, good mechanical properties can be maintained. It is also the ideal way to cast extremely thin sections. Small parts can often be cast in plaster casting as economically as in die casting.



PLASTER CAST TORQUE CONVERTERS. Vital parts of the Packard Ultramatic Transmission are cast in plaster by Alcoa. The intricate vanes of the turbine are perfect in detail as they leave the mold. The only machining operations required are simple clean-up and precision turning for fit. The housings are also cast in plaster. They must be strong and pressure tight. They have been tested at rotational speeds exceeding 10,000 rpm.

DIE CASTING...

is strictly a production process. Low unit cost, thin sections and extremely smooth surface finish are characteristic of parts made by this process. Ability to maintain high dimensional accuracy with this process often leads to substantial savings in subsequent machining and finishing costs.



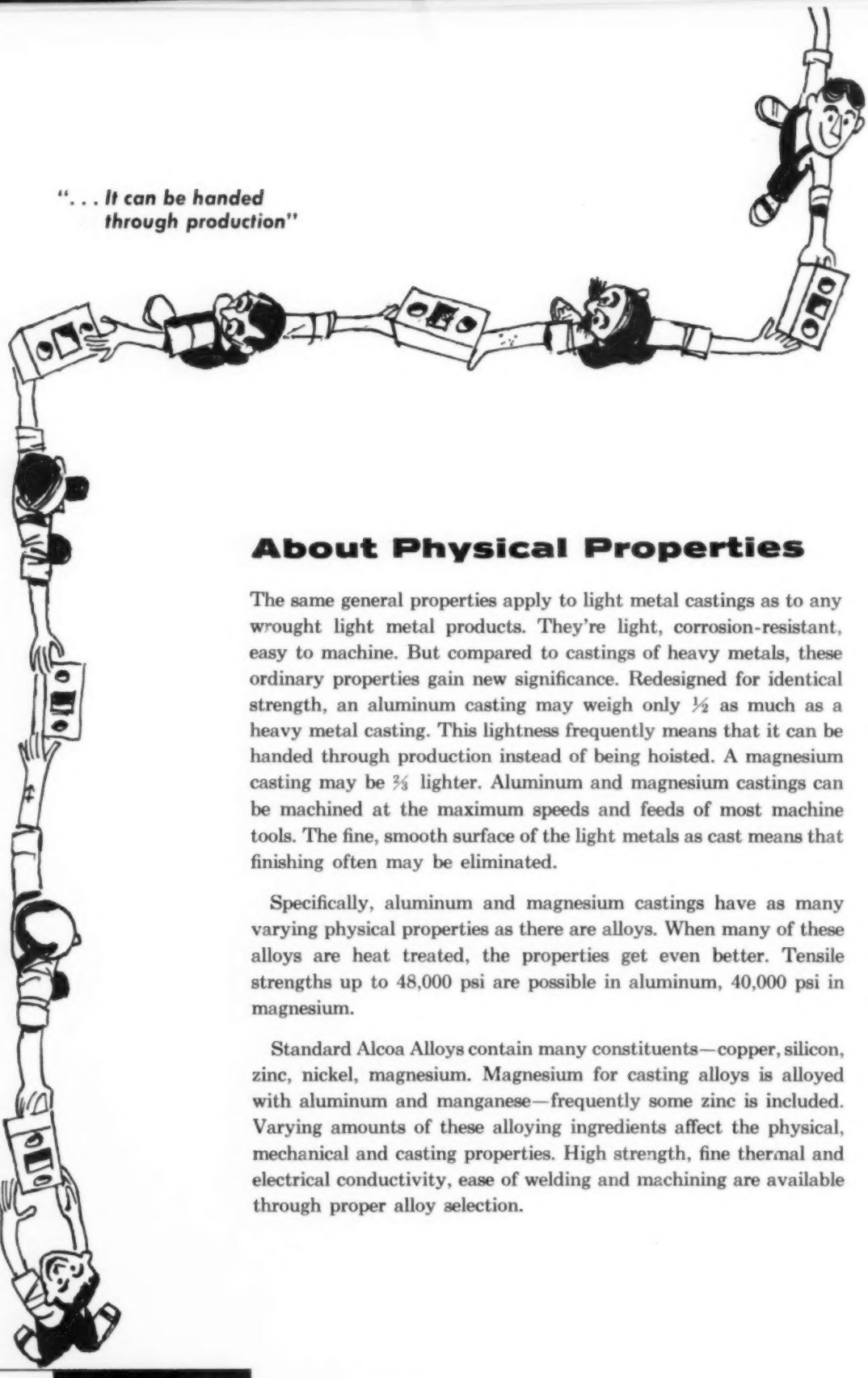
Die castings may weigh anywhere from a fraction of an ounce to 20 pounds and more. They have been produced up to 84 inches in length. Tolerances as low as .0015 inch per lineal inch can be maintained by this process. Sections as thin as .050 - .065 inch have been cast.

Because die castings can be produced in such large quantities, you will find that in many cases they compete favorably with other fabricating processes such as stamping and impact extruding.

DIE CAST CLUTCH HOUSING. This part was one of the first structurally stressed die castings ever made. It is the clutch housing for an automotive engine. It is also the assembly which supports the entire rear portion of the engine. When finished and assembled on the car, this die casting is actually less expensive in aluminum than it was in cast iron. Weight saving was considerable.

Use this check chart of the four casting processes to answer initial design considerations for aluminum and magnesium.

	Sand	Permanent-Mold	Plaster	Die Castings
Strength	2	1	3	2
Smoothness	4	3	2	1
Detail	3	2	1	1
Thin section	3	2	1	1
Tolerances	4	3	2	1
Tool cost	1	2	3	4
Price—Small runs	1	3	2	4
Price—Large runs	4	2	3	1
Possibility to save machining	4	3	2	1
Pressure tight	3	1	3	2
Speed of Production	4	2	3	1



About Physical Properties

The same general properties apply to light metal castings as to any wrought light metal products. They're light, corrosion-resistant, easy to machine. But compared to castings of heavy metals, these ordinary properties gain new significance. Redesigned for identical strength, an aluminum casting may weigh only ½ as much as a heavy metal casting. This lightness frequently means that it can be handed through production instead of being hoisted. A magnesium casting may be ⅔ lighter. Aluminum and magnesium castings can be machined at the maximum speeds and feeds of most machine tools. The fine, smooth surface of the light metals as cast means that finishing often may be eliminated.

Specifically, aluminum and magnesium castings have as many varying physical properties as there are alloys. When many of these alloys are heat treated, the properties get even better. Tensile strengths up to 48,000 psi are possible in aluminum, 40,000 psi in magnesium.

Standard Alcoa Alloys contain many constituents—copper, silicon, zinc, nickel, magnesium. Magnesium for casting alloys is alloyed with aluminum and manganese—frequently some zinc is included. Varying amounts of these alloying ingredients affect the physical, mechanical and casting properties. High strength, fine thermal and electrical conductivity, ease of welding and machining are available through proper alloy selection.

About Finishes

Light metal castings can be finished by all possible methods. They can be sandblasted, etched, burnished, tumbled, shot peened, wire brushed and all the other common mechanical and chemical means.

Recently, great strides have been made in anodizing aluminum castings. The special Alcoa hard anodized coating can be applied to aluminum castings to give them a surface hardness that a file can't touch.

And aluminum castings can be plated with any commercial metal—chromium, zinc, nickel, copper, brass, silver and gold. Alcoa-developed techniques make electroplating practical from both a performance and cost standpoint.

Paint, lacquer and even vitreous enamel can be successfully applied to light metal castings. Standard cleaning and priming techniques used with any of the wrought forms work well on castings.

Generally speaking, magnesium castings are finished by chemical method. Frequently, a simple chrome pickle is used. However, decorative and extremely hard coatings are available through various chemical and electrochemical processes.

Painting magnesium requires good surface preparation. Many of the chemical treatments are excellent primers for subsequent paint coats.

Magnesium has been electroplated with nickel and subsequently with chromium. Copper and cadmium have also been applied. However, the plating of magnesium has not yet been placed on a commercial basis.

"... A surface hardness that a file can't touch"

The Important Design Considerations

The designer can effect considerable savings by becoming familiar with a few general design rules. Actually, the more he learns about foundry practices, the better are his chances of making savings. A good way to do this is by writing for a free copy of Alcoa's 142-page book, *Casting Alcoa Alloys.*

You will notice, that the casting alloys vary widely in physical properties and castability. It is important not to insist on exceptional performance if the end use of the product does not require it. As a general rule, the high-strength alloys cost more, and are more difficult to cast.

From a foundry standpoint, it is desirable to maintain uniform sections throughout a casting. Variations in section tend to cause internal strains, cracking and shrinkage. When necessary to join thick and thin sections, use a gradual increase in thickness of the thinner section toward the junction.

Rib thickness should be held to 1½ times the thickness of the section to which it is joined. Wherever practical, the ribs should be designed so that they will project into the bottom part of the mold to facilitate metal flow. This minimizes the possibility of the ribs being unsound.

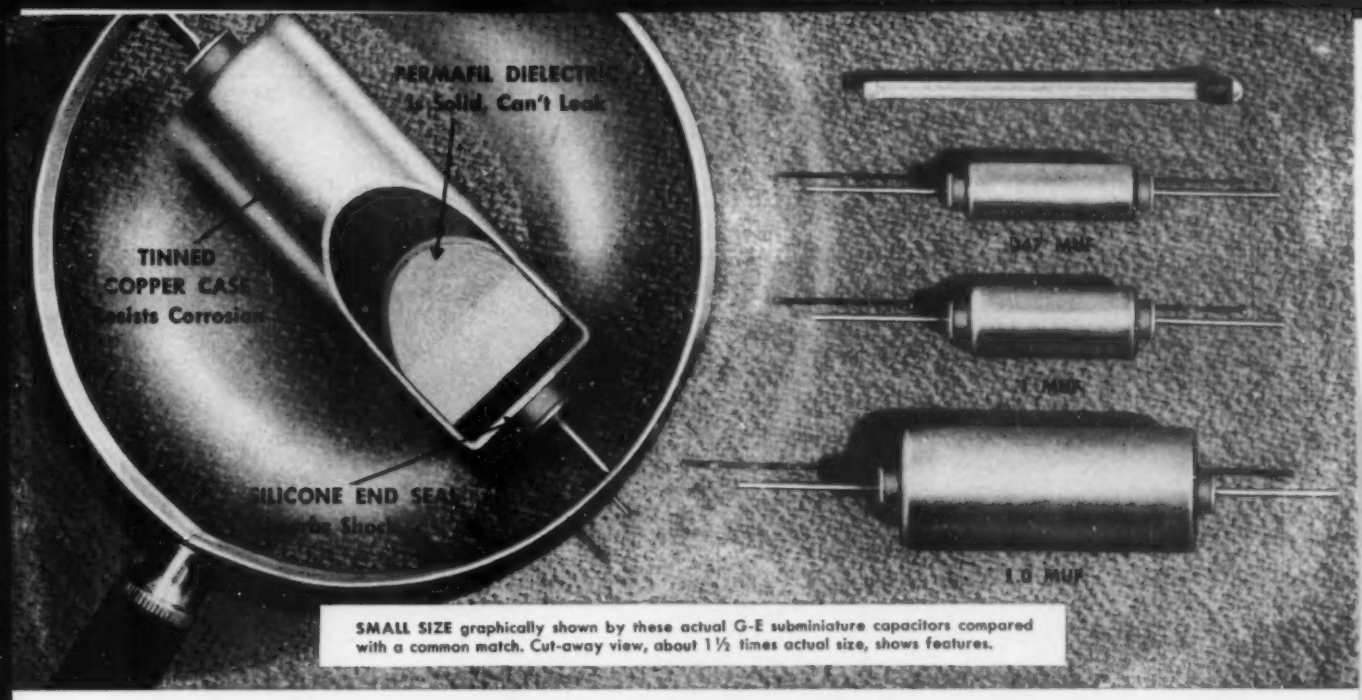
Generous fillets and blending minimize cracking and shrinkage. They also provide more even distribution of service loads. If the thickness of the larger of two adjoining sections exceeds the thickness of the smaller by more than 50 per cent, blending should be used in addition to fillets.

Be sure to specify locating points so that both the machine shop and the foundry will check the casting at the same places. For most accurate results, the locating points should be as far apart as the casting size will permit.

You can be sure that casting specialists at Alcoa foundries and in your local Alcoa sales office will work closely with you in your designs and alloy selections.

Your Next Step Write for our casting book. Don't forget to use your company letterhead and let us know what your job function is. If you have specific questions about castings, there is an Alcoa sales engineer near you, ready to give you the answers. Look for Alcoa under "Aluminum" in your classified phone book. Don't feel that just because you may not buy castings within the next week, or month, or year, that you shouldn't use his time and talents freely. That's what he's there for. ALUMINUM COMPANY OF AMERICA, 1992-G Alcoa Bldg., Pittsburgh 19, Pa.

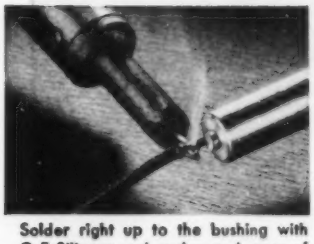
Sand Foundries at—Bridgeport, Connecticut; Buffalo, New York; Cleveland, Ohio; Detroit, Michigan; Vernon, Calif. Die-Casting Plants at—Garwood, New Jersey and Chicago, Illinois. Plaster casting foundries at—Bridgeport, Connecticut; Cleveland, Ohio; Detroit, Michigan and Vernon, Calif.



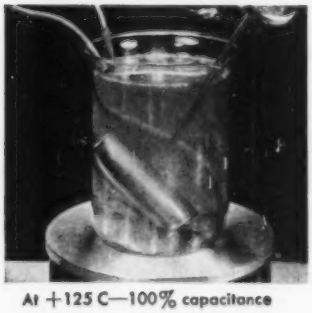
SMALL SIZE graphically shown by these actual G-E subminiature capacitors compared with a common match. Cut-away view, about 1½ times actual size, shows features.

New G-E subminiature metal-clad capacitor line features solid dielectric and silicone end seals

FOR OPERATION FROM −55 C TO +125 C WITHOUT DERATING



Solder right up to the bushing with G-E Silicone end seal—no danger of cracking glass.



At +125 C—100% capacitance

At −55 C—less than 7% loss

Designed specifically for electronic equipment, this new line of General Electric subminiature capacitors provides the utmost reliability under the most severe operating conditions combined with small size, no liquid leakage, and high insulation resistance. They will operate from −55 C to +125 C without derating and up to +150 C with proper derating.

These G-E subminiature metal-clad capacitors meet all test requirements of JAN-C-25 and the proposed MIL-C-25A and can be supplied in both tab and exposed foil designs.

Excellent electrical characteristics are assured by the use of Permafil solid dielectric. Capacitance varies only 1 percent over the temperature range from 0 C to +125 C and only 7 percent over the entire range from −55 C to +125 C.

Exceptional shock resistance provided by exclusive G-E silicone end seals. This seal meets the moisture resistance tests of JAN-C-25 with d-c potential applied.

Muf ratings of these new G-E subminiature capacitors range from .001 to 1.0 muf in voltage ratings of 100, 200, 400 and 600 volts d-c working. They can be operated at full voltage up to altitudes of 50,000 feet.

Case sizes range from .235 inches in diameter and $\frac{11}{16}$ in length to 1 inch diameter and $2\frac{5}{8}$ inches in length.

Liquid-filled metal-clad line also available with G-E Pyranol* dielectric for operation from −55 C to +85 C **without derating.** These subminiature capacitors also incorporate the silicone end seal for maximum shock resistance and can be supplied in either tab or foil designs in ratings from .001 to 1.0 muf in voltages of 100, 200, 400, and 600 volts d-c working.

If your requirements demand the highest performance standards for subminiature capacitors, check with your nearest G-E Apparatus Sales Office for exact delivery information . . . or write to General Electric Company, Section 442-8, Schenectady 5, N. Y.

1879 75 1953 YEARS OF ELECTRICAL PROGRESS

*Registered trade-mark of General Electric Company.

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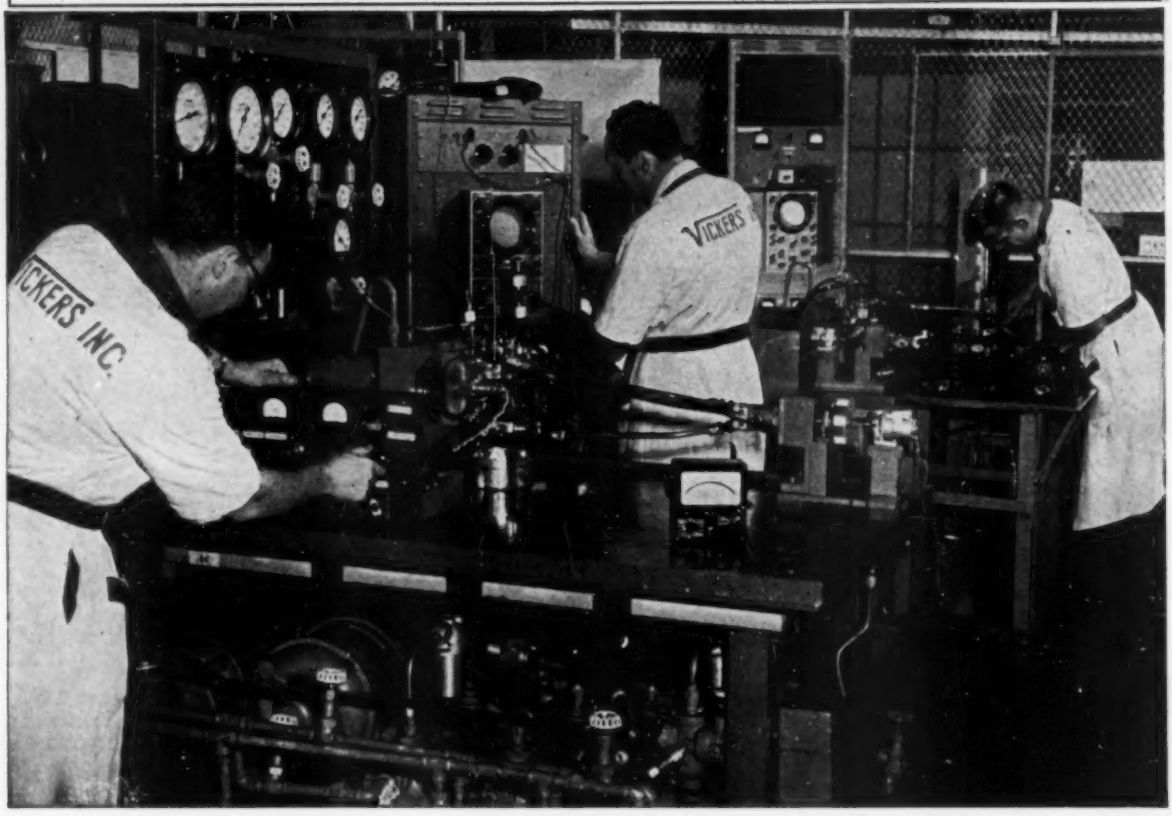
GENERAL ELECTRIC

ONE OF A SERIES

You Get Many Benefits by Specifying VICKERS Hydraulics



Research | that means improved oil hydraulic equipment

The list of pioneering developments in hydraulics contributed by Vickers research is long and impressive. Among the most important are:

Hydrostatic Relief Valve • Commercial Power Steering • Balanced Vane Type Pump • Flow Control Compensator • Axial Piston Pump and Motor

These are fundamental developments that have been of vital importance in the progress of hydraulics. They are representative of a large line of equipment that, with Vickers experienced application, assures you the best in any type of hydraulic operation. Vickers, with unmatched laboratory and basic research facilities, continues to lead the way in the oil hydraulics industry.

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Application Engineering Offices: **ATLANTA • CHICAGO (Metropolitan) • CINCINNATI • CLEVELAND DETROIT • HOUSTON • LOS ANGELES (Metropolitan) • NEW YORK (Metropolitan) • PHILADELPHIA PITTSBURGH • ROCHESTER • ROCKFORD • SEATTLE • TULSA • WASHINGTON • WORCESTER**

ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921

6357

ALUMINUM TUBE

Made from 2 S and 3 S aluminum; 2 S in sizes ⅛" O.D. to 1⅜" O.D., nominal composition of 99% of aluminum; and 3 S in sizes ⅛" O.D. to 2¾" O.D., 97% aluminum and 1.25% of manganese.

ELECTRIC-WELDED STEEL TUBE

The same rigid controls that we exercise in making Wolverine seamless tube are employed in making Wolverine Electric-Welded Steel Tube. Available in outside diameters ¼" to 3" — in analyses: SAE 1010, SAE 1015, SAE 1020, SAE 1025, SAE 1030.

STEPPING AHEAD

These tubes—carrying the distinguished Wolverine mark of top quality—are always up front.

Why are they in this leading position? What gives them their unique quality? Not men and machines alone. No, sir!

Look beyond the equipment and the guiding hands that produce these Wolverine tubes and you will realize the tireless research and development going on continuously in order that your particular tube requirements can be satisfied. We try to prepare not only for your current tubing needs but those of tomorrow as well.

We must stay ahead of the procession, ever alert to changing conditions, to be ready to meet your future needs.

You can always feel confident that Wolverine tube will lead the way toward giving you top tube performance.

COPPER TUBE and COPPER BASE ALLOY

Quality-controlled from ore to finished product. Made in popular sizes to give you long, dependable service. Wolverine is also an excellent source for integral finned tube (Wolverine Trufin*) to meet your specific needs. Besides round tube, Wolverine can furnish oval, square and hexagon shapes.

WOLVERINE TUBE DIVISION
of CALUMET & HECLA, INC.

ESTABLISHED 1916

Manufacturers of Tubing Exclusively

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Plants in Detroit, Mich. & Decatur, Ala. *Sales offices in Principal Cities*

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Wolverine Trufin and the Wolverine Spun End Process available in Canada through the Unifin Tube Co., London, Ontario.

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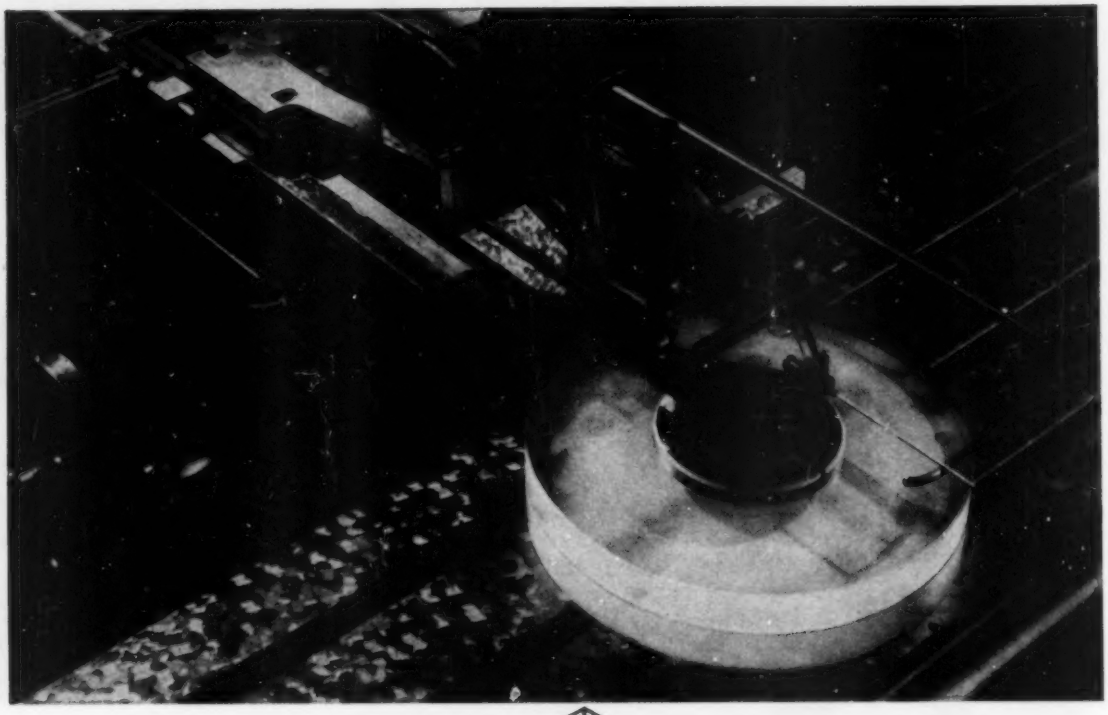
TEN DIFFERENT GRAPHITAR®
(CARBON-GRAPHITE)
PRODUCE DIFFRACTION GRATINGS



ruling the diffraction grating — The diffraction grating that breaks down the light rays in spectrometers is an aluminized glass disc with as many as 210,000 equally spaced lines tooled across its surface. This grating must be able to separate light rays whose wave lengths sometimes vary by less than one-billionth of an inch. A "ruling engine" is so sensitive that slight temperature and atmospheric changes can affect its accuracy. Ten GRAPHITAR bearings at strategic locations in the machine help make operation of the ruling engine practical and account for much of its precision and accuracy. These GRAPHITAR bearings are dimensionally stable within one-millionth of an inch and will not expand or contract as a result of temperature or atmospheric changes. In this application, the GRAPHITAR bearings were soaked in oil to provide unusually smooth, self-lubricating sliding surfaces. But for most applications, GRAPHITAR parts can be used without lubrication.

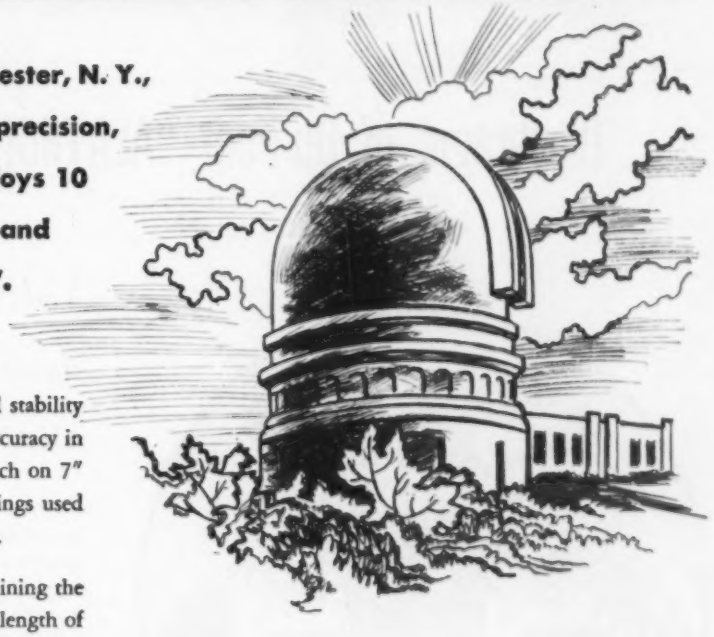
1. *The radial bearings carrying the precision screw. (Replaces ball-bearings)*
2. *Thrust bearing for precision screw. (Replaces usual hardened steel or sapphire ball against flat diamond)*
3. *Diamond carriage sliding bearings. These are lubricated by permitting the oil to soak through the Graphitar.*
4. *Diamond pivot bearings.*
5. *Sliding bearings for grating carriage.*
6. *Thrust bearing for worm shaft.*
7. *Thrust bearing for slave screw.*
8. *Sleeve bearing for worm shaft.*
9. *Corrector arm sleeve bearing.*
10. *Diamond lifter sliding bearing.*

177

THE UNITED STATES

PARTS HELP BAUSCH & LOMB RULING ENGINE WITH MICRO-INCH ACCURACY

Bausch & Lomb Optical Co., of Rochester, N. Y., world renowned manufacturer of precision, scientific optical instruments, employs 10 Graphitar bearings in its unique and highly specialized "ruling engine".



These GRAPHITAR bearings provide dimensional stability within one-millionth of an inch for micro-inch accuracy in cutting 15,000-30,000 equidistant lines to the inch on 7" aluminized glass blanks to make diffraction gratings used by science and industry for spectroscopic-analysis.

SPECTROSCOPIC-ANALYSIS is a method of determining the composition of an object by measuring the wave length of the light rays it gives off . . . In California's Mt. Palomar Observatory, home of the world's largest telescope, spectroscopic-analysis is used by astronomers in their daily studies of the celestial world around us.

As David Richardson of the Bausch & Lomb Scientific Bureau states, "GRAPHITAR has proven to be unsurpassed as a bearing material where very close tolerances must be maintained and where frequent starting and stopping under heavy loads is a problem. So-called breakout friction is minimized when GRAPHITAR is used.

"The micro-inch accuracy required for ruling diffraction gratings is greatly facilitated through the use of GRAPHITAR. We have replaced other types of bearings with GRAPHITAR at all the critical points in our grating ruling engine and have been able to demonstrate real improvement in each case.

"The final fit on all bearings was accomplished by hand scraping until good contact was achieved over the entire bearing area. Lapping is never used as we wish to avoid charging the GRAPHITAR with abrasive particles. All bearings are used either under oil or with oil supplied by soaking through the GRAPHITAR.

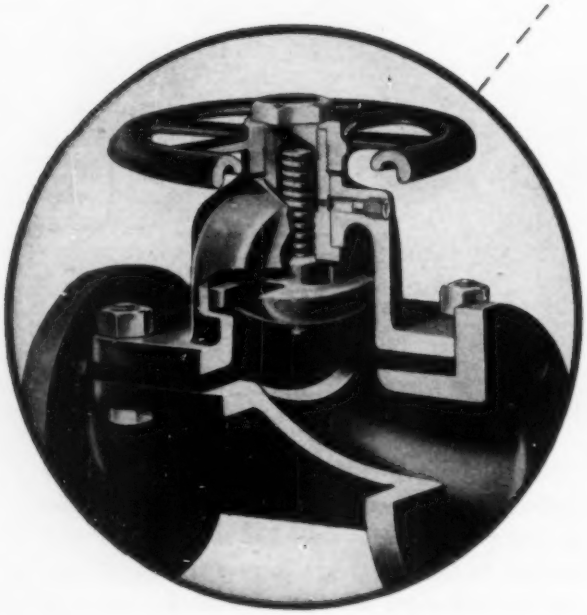
"We consider the application of GRAPHITAR to grating ruling engines to be a major advance in the achievement of extreme accuracy."

As in the Bausch & Lomb ruling engine, GRAPHITAR has been the only completely successful material in hundreds of applications as seals, bearings, rings, vanes, valves, etc. Write us today for complete information.

GRAPHITE COMPANY

DIVISION OF THE WICKES CORPORATION, SAGINAW, MICHIGAN

Diaphragm of Du Pont "ALATHON" cuts down-time



Valve manufactured by
Hills-McCanna Co., Chicago

Valve part withstands flexure and chemical attack... lowers costs

In adapting its Saunders Patent diaphragm valve for handling high concentrations of corrosive chemicals, the Hills-McCanna Company required a diaphragm material that could withstand repeated flexure as well as chemical attack. Tests showed that materials which could resist the chemicals would break down mechanically after short use.

They found the answer in a diaphragm molded of Du Pont "Alathon"* polyethylene resin. Tough, resilient "Alathon" stands up under constant flexing. Mechanical failures have been virtually eliminated. "Alathon" is resistant to most chemicals, too. These diaphragms are used in valves handling such corrosive chemicals as 98% sulfuric acid heated to 125°F. at 100 psi, as well as high concentrations of other industrial chemicals. In use, they have meant lower operating and maintenance costs, less down time, increased production.

Du Pont "Alathon" has a unique combination of mechanical, chemical and electrical properties. It is used for such varied applications as chemical carboys, squeeze bottles, flexible housewares and toys, and insulation for TV lead-in wire. Its low specific gravity (0.92) and ease of molding permit mass-production economies through rapid injection molding.

Perhaps "Alathon" can help you improve or develop a product. For full information on "Alathon" and other members of the Du Pont family of plastic engineering materials, write: E. I. du Pont de Nemours & Co. (Inc.), Polychemicals Department, Room 107A Du Pont Bldg., Wilmington 98, Del.

*REG. U. S. PAT. OFF.

DU PONT
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BETTER THINGS FOR BETTER LIVING
...THROUGH CHEMISTRY
Polychemicals
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AB Breakers pioneer greater capacity— smaller size

Always the leader in better-engineered circuit protective devices, Westinghouse sets a new pace with four compactly designed products that spell more capacity in less space than ever before possible.

The new J Breaker is only 10⅛″ high compared with 15½″ for conventional 225-amp breakers. Saves at least 34% mounting space in panels, switchboards, control cabinets and other enclosures.

The new E Breaker, formerly rated 50 amps, has been redesigned for 100 amps with no increase in size. A panel of 100-amp E's gives the same capacity but saves the price of heavy duty panelboards.

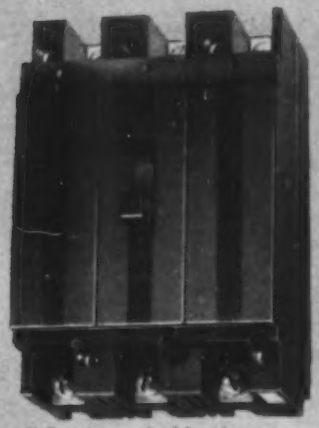
The new Quicklag Plug-in Thermal-magnetic De-ion® Breaker saves 25% mounting space. Plug-in contacts speed assembly. New type terminals end looping of wires.

The new 60-amp Visible Blade De-ion Switch is a fusible or non-fusible disconnect for all types of control panels up to 50 hp, 600 volts a-c. It's smaller, has higher interrupting capacity than any device of comparable rating.

These new products are available now, fully listed by Underwriters' Laboratories, Inc. For complete details call your Westinghouse Representative or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pa. J-30144

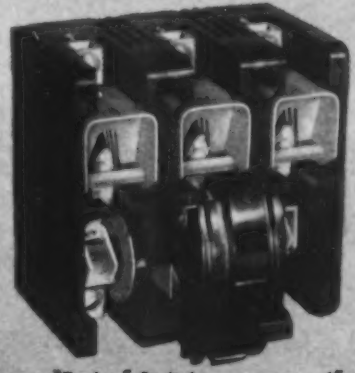
YOU CAN BE SURE... IF IT'S Westinghouse

225 amp J Breaker — saves 34% space

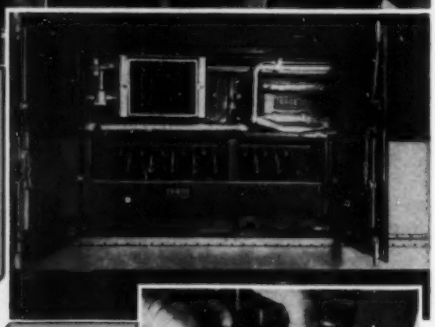


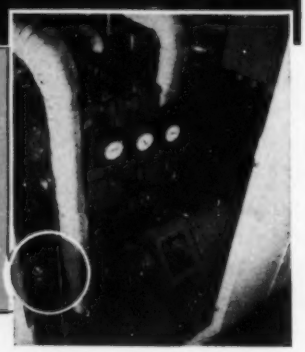
100 amp E Breaker — doubles former capacity

Quicklag Breaker — 25% smaller



60 amp "De-ion" Switch — measures 4" x 4"





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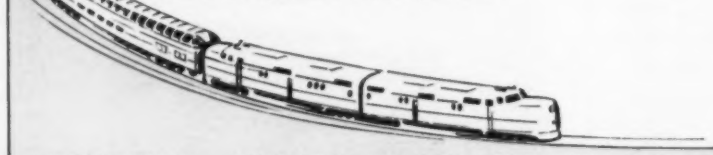
THE TRANE COMPANY
Air
Conditioning Units
on
LORD
MOUNTINGS...

The new Super-Dome Passenger Cars of the Milwaukee Railroad are air conditioned to maintain comfortable temperature at all times. A 20 ton capacity Trane Compressor and a 20 ton capacity Trane Condenser in each car do this important job. Lord Mountings protect these Trane Units from vibration and shock and prevent transmission of the unit vibration to the car thus assuring passenger comfort. In these ultra-modern cars the passengers enjoy the benefits of healthful, temperate air. This is another of the many examples of Lord versatility in assisting designing engineers to solve difficult mounting problems. You are invited to consult with us on the application of Lord Vibration and Shock Mountings and Bonded-Rubber parts to improve the operation of your product.



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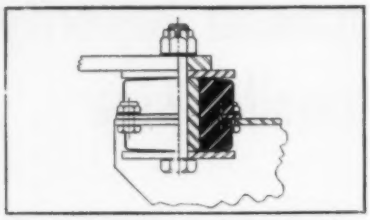
LORD BONDED RUBBER
Headquarters for
VIBRATION CONTROL

ADVERTISEMENT

Railroad Equipment Protected By Lord Mountings

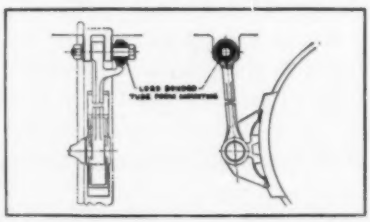
A special plate form mounting has been designed by Lord Engineers for use as a shock mounting for engine-generator and motor-compressor units installed on railroad rolling stock. The problem was to design a Lord Mounting which would minimize the shocks of coupling and uncoupling cars and thus prevent damaging the undercar equipment referred to above.



An existing Lord plate form mounting design was utilized with a steel tubing insert in the elastomer to increase the stiffness of the mounting. Tooling and research expense were thus saved by this unusual application of Lord Mountings previously designed to solve another similar problem.

Excessive Wear Eliminated By Use of Lord Mountings

A recently designed Lord Mounting has solved a problem for a manufacturer of brake assemblies in the railroad field. A Lord Tube Form Mounting design was utilized as a joint for the brake hanger mechanism. Through the use of rubber bonded to metal sufficient motion was permitted to compensate for shock while eliminating wear on the pin and joint at the point of motion.

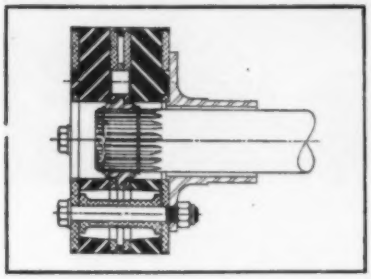


Lord Engineers determined the amount of resiliency required to effect a firm joint while permitting sufficient movement to eliminate excessive wear. An existing design was used with the correct elastomeric compound to meet the necessary requirements. Thus a considerable saving was achieved.

ADVERTISEMENT

Lord Flexible Coupling Flies With Kaman Helicopter

The Kaman K-5 helicopter presents an interesting application of the LORD J-5329-2 flexible coupling with the Boeing 502-2 gas turbine. The function of the coupling in this case is to absorb the torsional vibrations of the system and isolate the turbine from the rotors. However, the unit also serves to accommodate angular or parallel misalignments due to manufacturing tolerances or dynamic motions.



The unique design of the installation provides maximum accessibility and economical maintenance through the use of concentric driving and driven shafts. The inner member of this pair is the engine shaft which drives the coupling hub through a splined connection. Precompressed against the splined hub are the two bonded rubber coupling halves which transmit the engine torque in shear of the rubber. Four through-bolts connect the outer plates of the coupling halves to the driven hub and also serve as the safety interlock in case the rubber sections are destroyed. The first gear of the transmission is mounted on this driven hub and feeds power on through the system in to the helicopter rotors.

For over thirty years the Lord organization has specialized in designing and producing Bonded Rubber Flexible Couplings, Vibration and Shock Control Mountings and Component Parts. The capabilities of Lord Engineering have proved their worth to designers of industrial and automotive equipment in many diversified fields as is indicated in this instance.

ON LAND, SEA AND AIR

LORD *Flexible Couplings*

TRANSMIT THE FULL POWER OF BOEING TURBINE ENGINES

HERE again you see at a glance Lord versatility in designing bonded-rubber components for a wide diversity of machines. The photo at top right shows the Boeing Gas Turbine-Driven Truck-Trailer for heavy cargo hauling. At the top left you see a United States Navy personnel boat driven by the Boeing Gas Turbine Engine. Directly beneath is the Kaman Helicopter powered by the Boeing Gas Turbine Engine; details are clear in the foreground. The Lord Bonded-Rubber Flexible Coupling designed for the job transmits the power in each machine.

Special requirements like these reach satisfactory and economical solutions at Lord, Headquarters for Vibration Control. We invite you to take advantage of more than a quarter century of design experience and craftsmanship.

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LORD MANUFACTURING COMPANY • ERIE, PA.

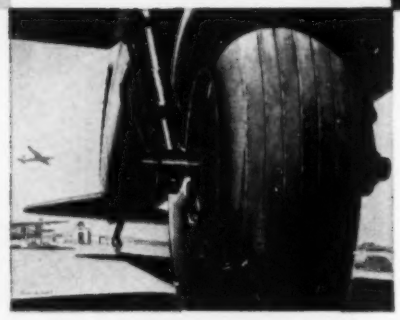
LORD BONDED RUBBER — *Headquarters for* **VIBRATION CONTROL**

OSTUCO TUBING is versatile!

OSTUCO TUBING is versatile!

OSTUCO TUBING is versatile!

OSTUCO TUBING is versatile!



OSTUCO TUBING is versatile!

a basic material in better design

From industry's drawing boards come more and more plans for products using OSTUCO Steel Tubing. Strong, light weight, easy to form, OSTUCO Tubing is found in everything from shock-absorbers to sewing machines and tricycles to table lamps. Biggest users of OSTUCO Tubing are industries famed for their standards of high quality—manufacturers of aircraft, automobiles, appliances, electric products, tools, and machinery.

Having our own steel source as a member of the Copperweld family and with facilities modernized and greatly expanded, The Ohio Seamless Tube Company is now, more than ever, *your best single source* . . . a tubing specialist that manufacturers, forges and fabricates all at one plant. Consult our experienced engineers about OSTUCO Tubing for your current requirement or for redesigning your products. Write for new informative catalog, "Ostuco Tubing."

From Your Blueprint . . . to Your Product
OSTUCO TUBING
Tapering • Swaging • Flanging • Bending
Upsetting • Expanding • Reducing • Beading
End closing • Spinning • Drilling • Slotting
Notching • Flattening • Shaping • Trimming
Threading • Angle Cutting • And Many Others

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Manufacturers and Fabricators of Seamless and Electric Welded Steel Tubing

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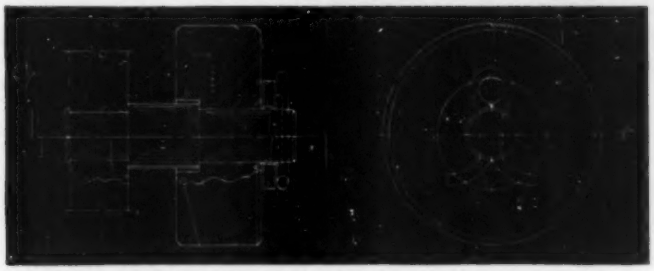
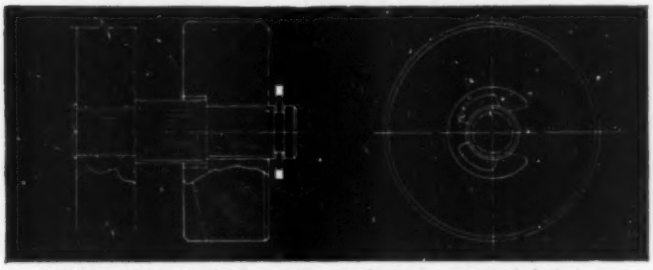
WALDES TRUARC RINGS REPLACE COTTER PINS...
SAVE 44% IN LABOR AND ASSEMBLY COSTS



COTTER PIN WAY: Flint wheel shaft in lighter assembly requires cotter pin, washer. Difficulty in drilling perfect hole causes rejects. Assembly is slow, costly.



TRUARC WAY: Waldes Truarc "E" ring fits into groove in shaft; locks assembly securely for life. Groove is quickly, easily cut...assembly is simple, speedy.

Brown & Bigelow, St. Paul, Minn., saved *$6.95 per thousand units* by incorporating Truarc Rings in the design for the REDI-FLAME compressed gas desk lighter! In spite of greater initial cost of Truarc Rings as against cotter pins, they were able to cut machining and assembly costs drastically—for an overall savings of 44%!

Redesign with Waldes Truarc Rings and you too will cut costs. Wherever you have a fastening problem...wherever you use machined shoulders, bolts, snap rings, cotter pins, there's a Truarc Ring designed to do a better job of holding parts together.

Waldes Truarc Rings are precision-engineered...quick and easy to assemble and disassemble. They can be used over and over again.

Find out what Truarc Rings can do for you. Send your blueprints to Waldes Truarc engineers for individual attention, without obligation.

COMPARATIVE COSTS

Cotter Pin Way		Truarc Way	
Material	*$ Per M*	*Material*	*$ Per M*
Shaft	.48	Shaft	.35
Cotter pin	.46	Truarc ring	8.68
Washer	1.50		
	2.44		9.03
Labor		*Labor*	
Shaft	10.22	Shaft	2.27
Washer	.72		
Assembly	9.28	Assembly	4.41
	20.22		6.68
TOTAL	$22.66	TOTAL	$15.71

TOTAL SAVINGS WITH TRUARC RINGS: $6.95 or 44%

For precision internal grooving and undercutting... Waldes Grooving Tool.

SEND FOR NEW BULLETINS ➡

WALDES

TRUARC

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WALDES KOHINOOR, INC., LONG ISLAND CITY 1, NEW YORK

WALDES TRUARC RETAINING RINGS AND PLIERS ARE PROTECTED BY ONE OR MORE OF THE FOLLOWING U.S. PATENTS: 2,383,047; 2,383,948; 2,410,552; 2,420,031; 2,428,341; 2,430,705; 2,441,849; 2,455,155; 2,483,300; 2,483,303; 2,487,032; 2,487,803; 2,491,306; 2,509,081 AND OTHER PATENTS PENDING.

Waldes Kohinoor, Inc., 47-16 Austel Place, L. I. C. 1, N. Y.
Please send engineering specifications and data on Waldes Truarc Retaining Ring types checked below. PN075

- ☐ Bulletin #5 Self-locking ring types
- ☐ Bulletin #6 Ring types for taking up end-play
- ☐ Bulletin #7 Ring types for radial assembly
- ☐ Bulletin #8 Basic type rings
- ☐ Send me information about the Waldes Grooving Tool.

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PACKINGS

TOP PERFORMANCE!

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Our latest packing developments help you increase efficiency.

A good example of Houghton's recent achievements in packing design is our new No. 1243-3—Synthetic *rubber impregnated* VIM Leather Cup Packings with qualities never before equalled! These packings combine leather's long life and low-friction coefficient with rubber's non-porous, heat resistant, resilient qualities. They are flexible, easily installed, provide leak-proof seals from 0 to 15,000 lbs. pressure, and withstand temperatures from —65° F. to 200° F. Two exclusive design features make these packings, in effect, "pre-loaded" and prevent deformation under pressure.

Our new Vix-Syn plant promises you stepped-up delivery.

When the growing demand for synthetic rubber packings called for expanded facilities, this additional, newly-constructed Vix-Syn plant was our answer. This modern plant was erected for Vix-Syn Synthetic Rubber Packings and precision molded rubber products exclusively. It is already turning out standard size homogeneous commercial packings in increasing quantities to supply the growing needs of the expanding hydraulic market.

Get Houghton's "Packing Standards" Book, illustrated. It is accepted as the standard by industry, and will be mailed without cost on request. Houghton was first to compile complete packing handbooks and to offer simplified standards to industry. For "Packing Standards" booklet, write: E. F. Houghton & Co., 303 W. Lehigh Avenue, Philadelphia 33, Pa.

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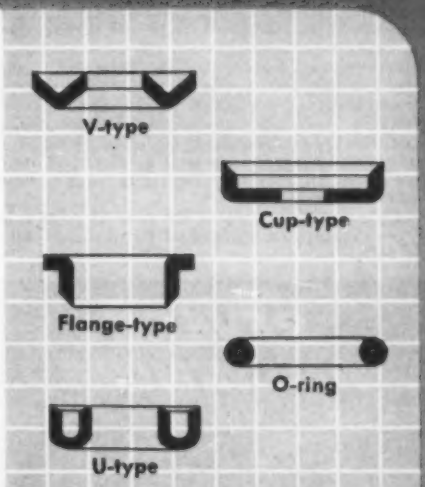
make HOUGHTON your best source for all packing needs!

Our bigger-than-ever line fills all your packing needs.

To meet your hydraulic and pneumatic packing needs, *Houghton has them all!* . . .

VIM LEATHER PACKINGS—Cup, flange, "U" and "V" types and back-up washers for use with "O" rings—for oil, air, water or gas applications—used for all pressures and for temperatures up to 200° F.

VIX-SYN SYNTHETIC RUBBER PACKINGS—Including homogeneous and fabricated packings, gaskets and adaptors—also "O" rings—both packing and gasket types.



Our expanded field service helps you solve design problems.

You'll find trained Houghton engineers in every industrial center, well equipped to help you with hydraulic and pneumatic packing problems. Call them with confidence for original packing designs. Or enlist their aid in recommending improvements on existing designs. They are backed up by a knowledge gained over 44 years of engineering service to designers.

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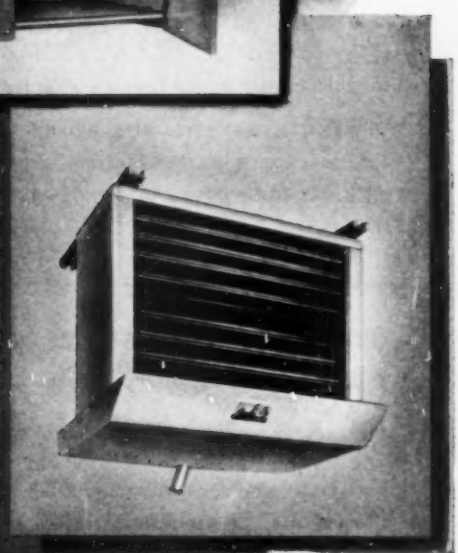

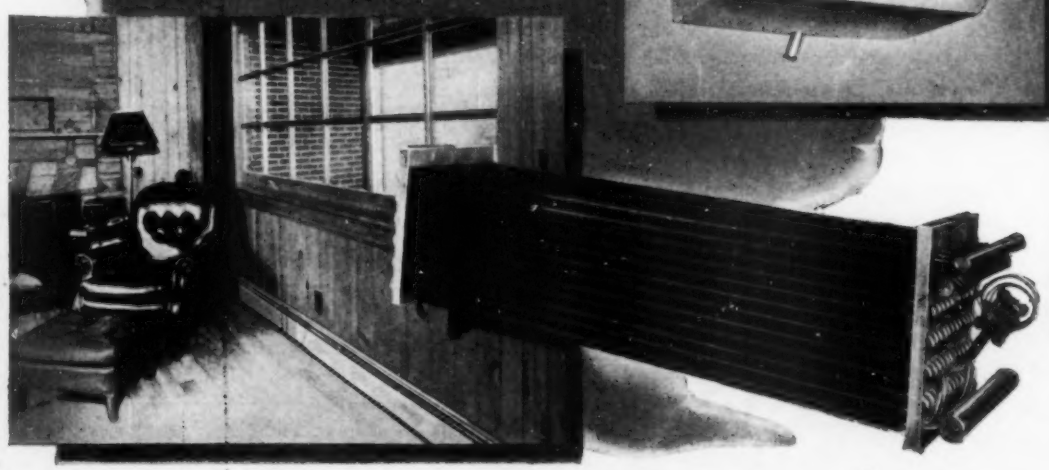

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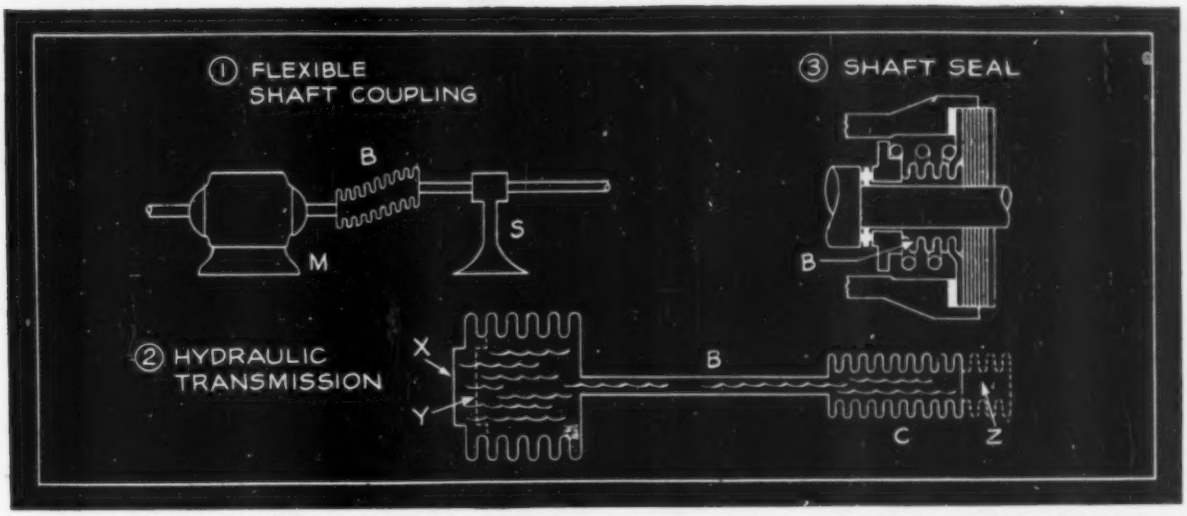
SEE REVERE'S "MEET THE PRESS" ON NBC TELEVISION EVERY SUNDAY

Bellows Digest

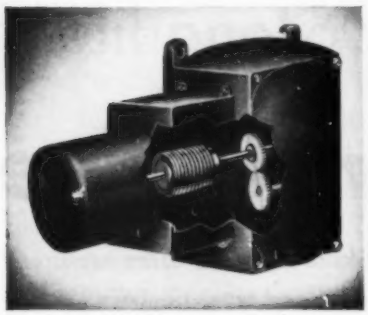
No. 6. Bellows used for Flexible Shaft Couplings, Hydraulic Transmission and Shaft Seals.



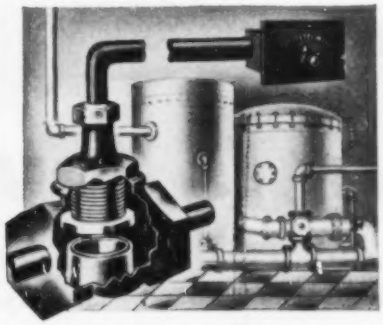
1. A SMOOTH, EVEN DRIVE even if shafts are misaligned is one of the major advantages of bellows shaft couplings over ordinary flexible couplings in many applications. Bellows (B) on driving shaft of small motor (M) transmits true, constant velocity to driven shaft (S).

2. "FRICTIONLESS LEVER SYSTEM" results when liquid filled bellows system is used in transmitting force. Large force at (X) moving large bellows through short distance (Y) is transmitted through tube (B) to small bellows (C), moving it through long distance (Z). Action may be varied or reversed by changing bellows sizes.

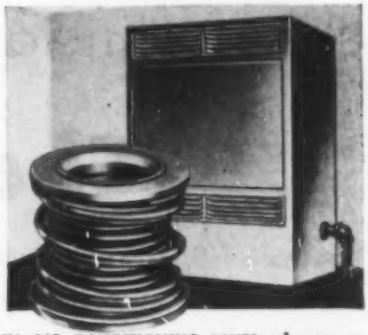
3. USED AS PACKING GLANDS, bellows shaft seals (B) prevent leakage of enclosed fluid around rotating shafts. All metal construction makes bellows ideal where seals are required to resist gases, corrosive liquids and extreme temperatures. Pressure on seal surfaces can be kept constant, regardless of a system's varying pressures.



SERVO MECHANISMS are typical applications benefited by the constant velocity drive and ease of alignment assured by Clifford bellows used as flexible couplings. Another big advantage over conventional couplings is the time-and-money-saving elimination of the need for precise alignment of motors and shafts.

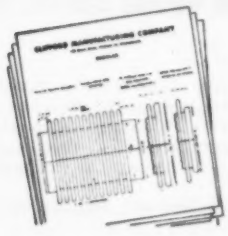


REMOTE CONTROL OF FLUID FLOW, in many types of processing equipment, is here provided by a Clifford bellows system. Valve in cutaway view is remotely controlled by liquid-filled bellows assembly governed by knob on control panel. Principle of hydraulic transmission of pressure can be used in wide variety of controls.



IN AIR CONDITIONING UNITS, where prevention of refrigerant gas leakage is vital, seals on compressor shafts must be leakproof and impervious to gases. That is why leading manufacturers of air conditioning equipment select Clifford bellows shaft seals for this important purpose. Seal surfaces can be finished to a flatness of five micro-inches.

MAYBE YOU, TOO, CAN BENEFIT from the use of Clifford Hydron Bellows assemblies. Besides their use as flexible shaft couplings, shaft seals and in hydraulic transmission, these flexible, leakproof, metallic bellows are also used to: (1) control and indicate pressure and temperature; (2) provide for thermal expansion; (3) transmit motion from one medium to another; (4) provide shock mountings or vibration dampening; (5) permit motion in a vacuum.



FREE! BELLOWS TEMPLATE KIT

Trace 20 most popular bellows sizes . . . fast . . . accurately. Kit, in handy cardboard envelope, includes full directions and details of Clifford bellows, simplifying tedious jobs — send for your kit today!

Write Clifford Manufacturing Company, 122 Grove Street, Waltham 54, Massachusetts. *Division of Standard-Thomson Corporation.* Sales offices in New York; Detroit; Chicago; Los Angeles; Waltham, Massachusetts.

38-2-11

If Your Design Problem

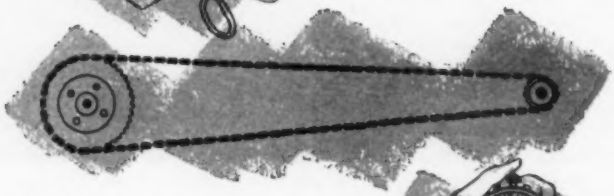
design flexibility

dependability

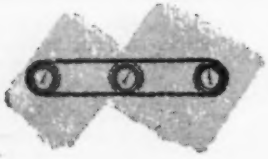
low initial cost

low overall cost

long centers



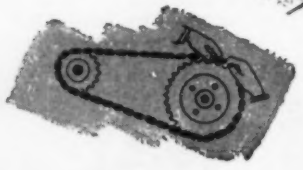
short



positive timing

heat

ease of installation



long life

Chain Is Your Answer

Yes, chain will solve any of these problems in both drive and conveyor service. The important point is to be sure you select the best chain to do the job. That's why so many designers make their selections from the complete Chain Belt line.

In the complete Chain Belt line there are literally hundreds of sizes and types of chain . . . but only one can be the *best* chain for your particular application. For example: for a high speed drive, Baldwin-Rex® Roller Chain is probably most efficient. For conveying cans, bottles, and jars

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BALDWIN-REX®

Chain

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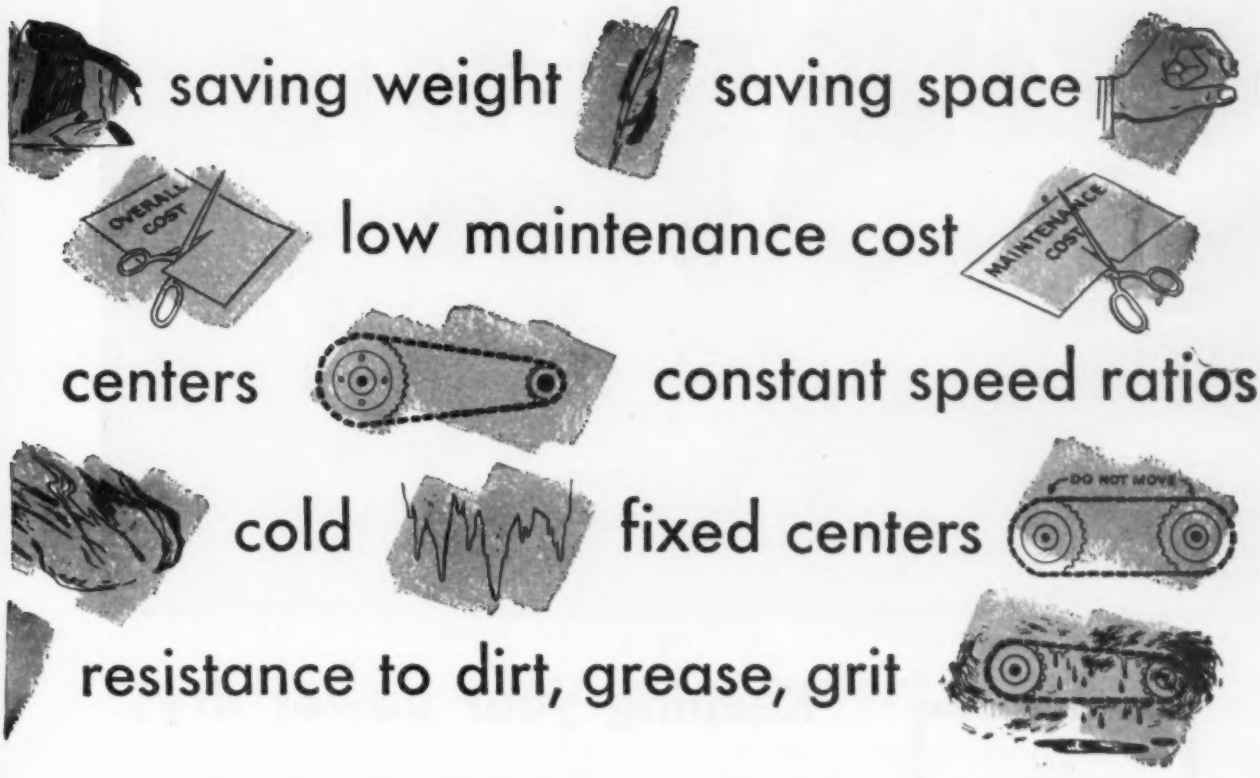

you choose between Rex TableTop® and Baldwin-Rex PlateTop, depending on load conditions; where loads are heavy and chain must operate in dust and dirt, some type of Rex Chabelco® is usually indicated.

Our Rex Field Sales Engineers are specially trained to help you with your chain selection problems. For more help, call your nearest Chain Belt branch office or write to Chain Belt Company, 4715 W. Greenfield Ave., Milwaukee 1, Wisconsin.

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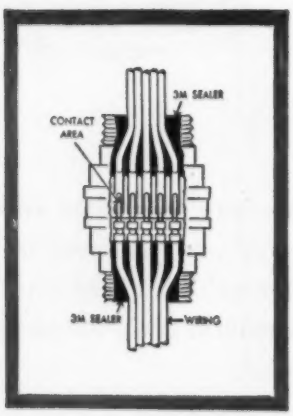
Gentlemen:
My chain selection problem is.....
.....
Please send me appropriate literature.
Name.....
Company.....*Dept*.....
Address.....
City.....*State*.....



Keeping your power dry!

Protecting our shores from invasion is only one of the jobs assigned to Navy aircraft. Another task, equally important, is for the plane to protect itself against its own "natural" enemies.

For instance, consider the possible effects of salt air and water, of moisture condensation, of vibration on the electric wiring that delivers power throughout the plane. How quickly these elements would destroy the aircraft—if not checked.

To help protect these power lines, 3M, working with McDonnell engineers and the U.S. Navy, developed EC-1120PC—a potting compound, not affected by vibration, that provides a permanent seal for wiring in plugs against moisture and salt air. It helps to keep your power dry!

See what adhesives can do for you . . .

There are virtually thousands of other 3M products developed for specific uses such as this, or for more general purposes. For the facts on 3M adhesives, sealers and coatings designed especially for industrial use, call in your 3M sales representative, or write directly to 3M, Dept. 47, 411 Piquette Ave., Detroit 2, Michigan.

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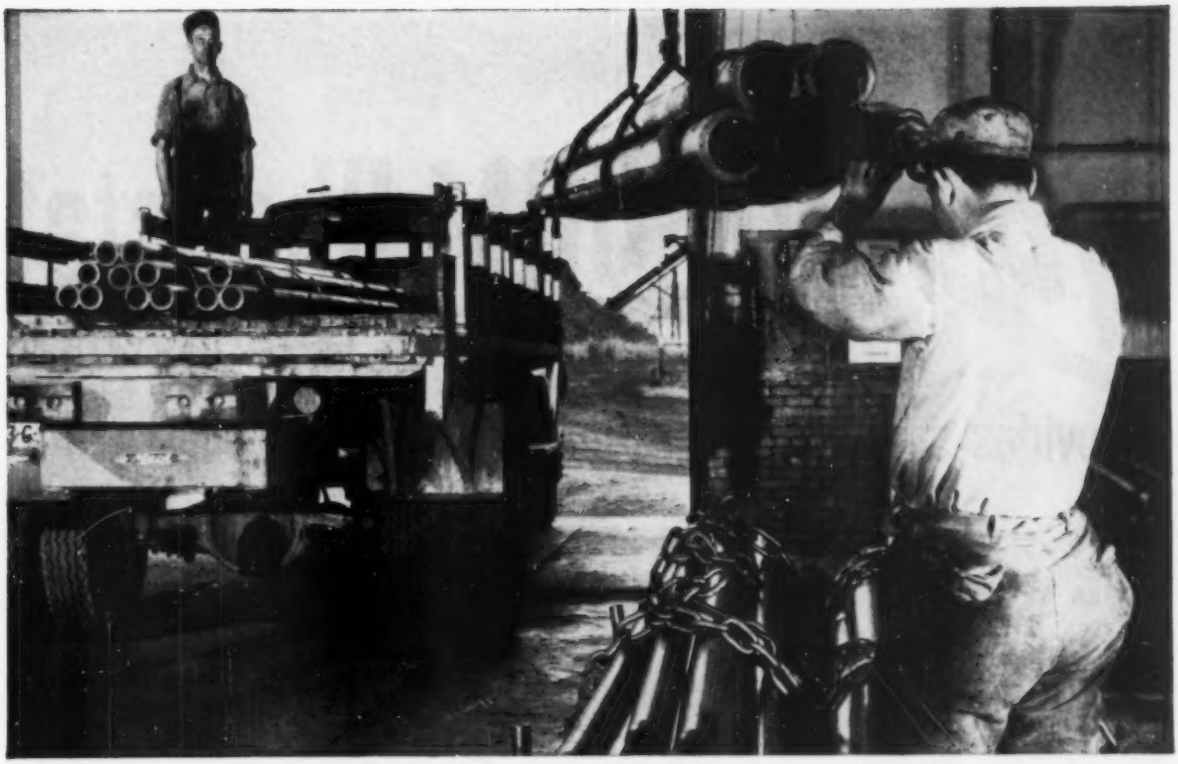

52100 tubing shipped within 24 hours after you order!

GOT a rush hollow-parts job? The Timken Company will ship less-than-mill-quantities of 52100 tubing within 24 hours after receipt of your order.

Timken® 52100 steel will do most of your hollow-parts jobs. It can be heat treated to file hardness and tempered back to any desired point. A high carbon steel, it is through-hardening in moderate sections, has high wear resistance and can often be used in place of more expensive steels. And it comes in sizes from 1″ to 10½″ O.D.

Here's a partial list of hollow-parts jobs for which Timken 52100 steel is used: aircraft parts, ball bearing races, pump parts and plungers, collets, bushings, spindles, grinding machine parts and precision instruments.

The Timken Company's unmatched experience, as a pioneer producer of 52100 tubing, has resulted in uniform quality from tube to tube and order to order. Rigid quality control checks every step of production.

For immediate delivery of your less-than-mill-quantity orders, write, wire or call The Timken Roller Bearing Company, Canton 6, Ohio. Cable address: "TIMROSCO".

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SPECIALISTS IN FINE ALLOY STEELS, GRAPHITIC TOOL STEELS AND SEAMLESS TUBING

NEW VITROHM Rheostat

with 6 exclusive features

provides smoother operation, finer control, longer life

1 **Pressed steel base plate** assures a sturdy, lightweight rheostat base. The black japanned finish is corrosion resistant.

2 **Balanced contact arm** reduces creep from vibration or shock. The arm is keyed directly to one end of the drive shaft.

3 **Solid brass rectangular contacts** provide more steps of control for any given plate diameter.

4 **Reflexed collector ring** supplies a self-cleaning surface. It is permanently held in position by Vitrohm enamel.

5 **Vitrohm enamel** permanently seals and insulates the resistance element, stationary contacts and collector ring.

6 **Contact shoe and bearing** are self-lubricated to provide exceptionally smooth control and low operating torque.

This new line of Vitrohm Pressed Steel Rheostats incorporates 21 advanced design features, including the 6 shown here. They are designed for a wide variety of industrial applications to give smoother operation, lower operating torque, longer life, and more control steps. From raw materials to finished product, close control over workmanship and continual inspection of every component is maintained. These are the most dependable and economical rheostats ever made by Ward Leonard – the leader in rheostat manufacture for over fifty years.

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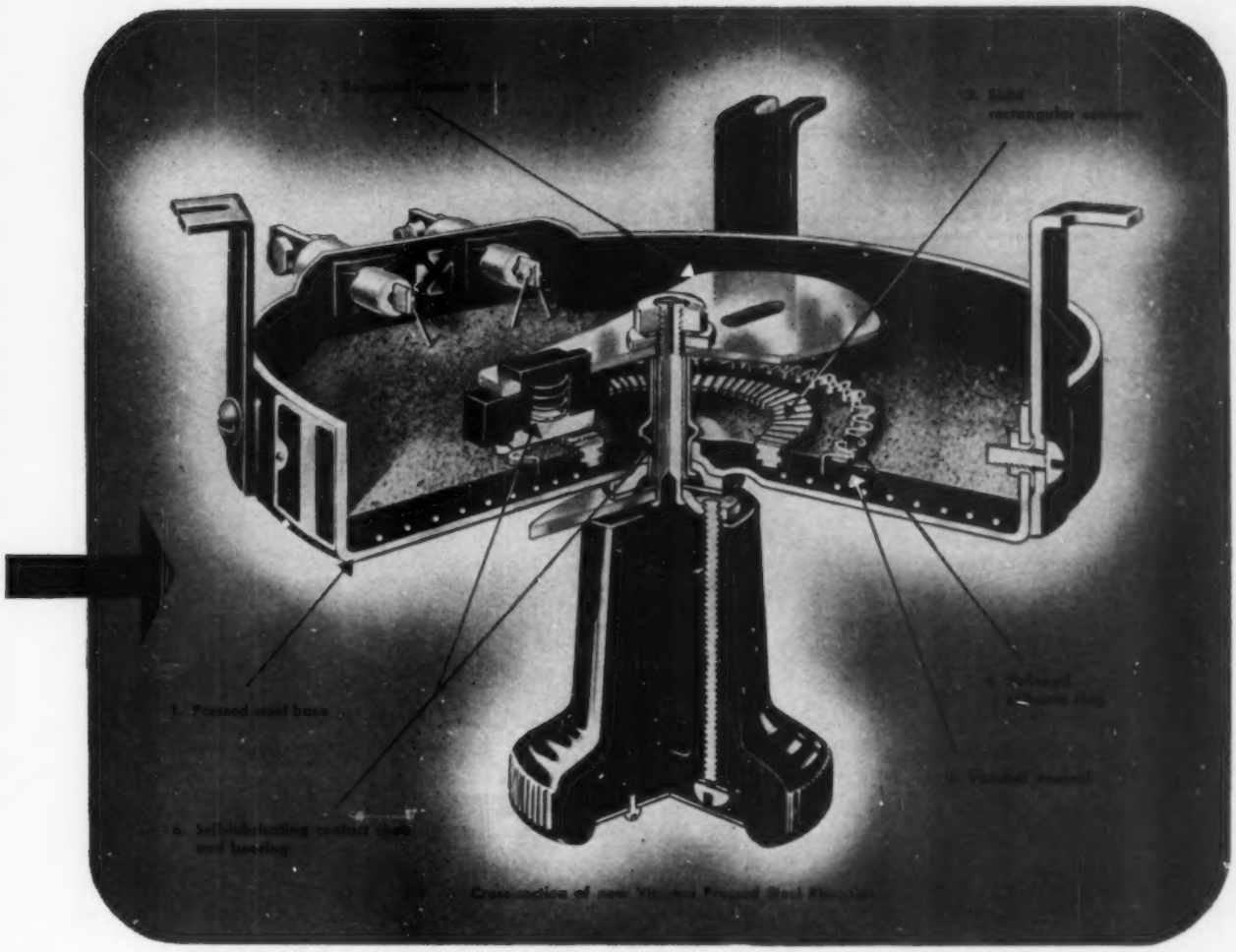
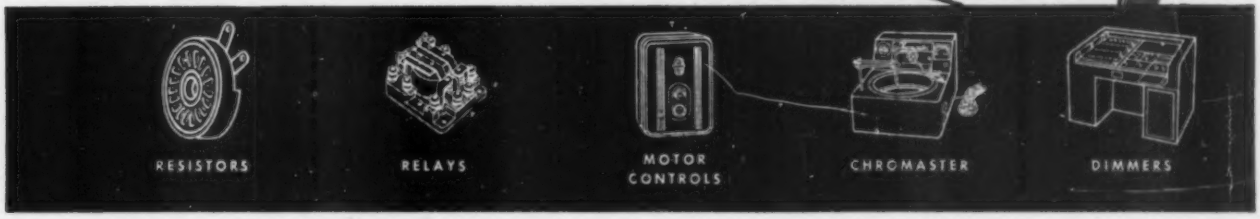


RHEOSTATS FOR EVERY APPLICATION

Ward Leonard manufactures the most complete line of power rheostats ever offered for industrial control applications. It includes standard and special designs for all current ratings up to 400 amperes. A complete description of the entire line with mountings, manual and motor drive accessories, a variety of enclosures, and optional features will be found in the *new* Ward Leonard Bulletin 60a. It will pay you to send today for your free copy. Write to Ward Leonard Electric Co., 63 South Street, Mount Vernon, N. Y.

3-17



Have you a temperature control problem from -20°F to 550°F?

KLIXON *Thermo-Snap* CONTROLS

can meet your requirements... often reduce costs, too!

What's your temperature control problem . . . high or low limit, fan control, temperature control . . . on boilers, clothes dryers, unit and space heaters, refrigeration and electronic equipment . . . Klixon Thermo-Snap Controls are now meeting the requirements for these and other uses in military and civilian products.

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Klixon Thermo-Snap Controls, hermetically sealed and open types, are available in many types, shapes and sizes, in a wide variety of operating temperature ranges.

Klixon Engineers, specialists in temperature control applications, can help you solve your specific problems. Write for their help or further information.

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Division of Metals & Controls Corporation

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simple, easy to use!

speed detailing and specifying!

...yours FREE!

the newest, latest

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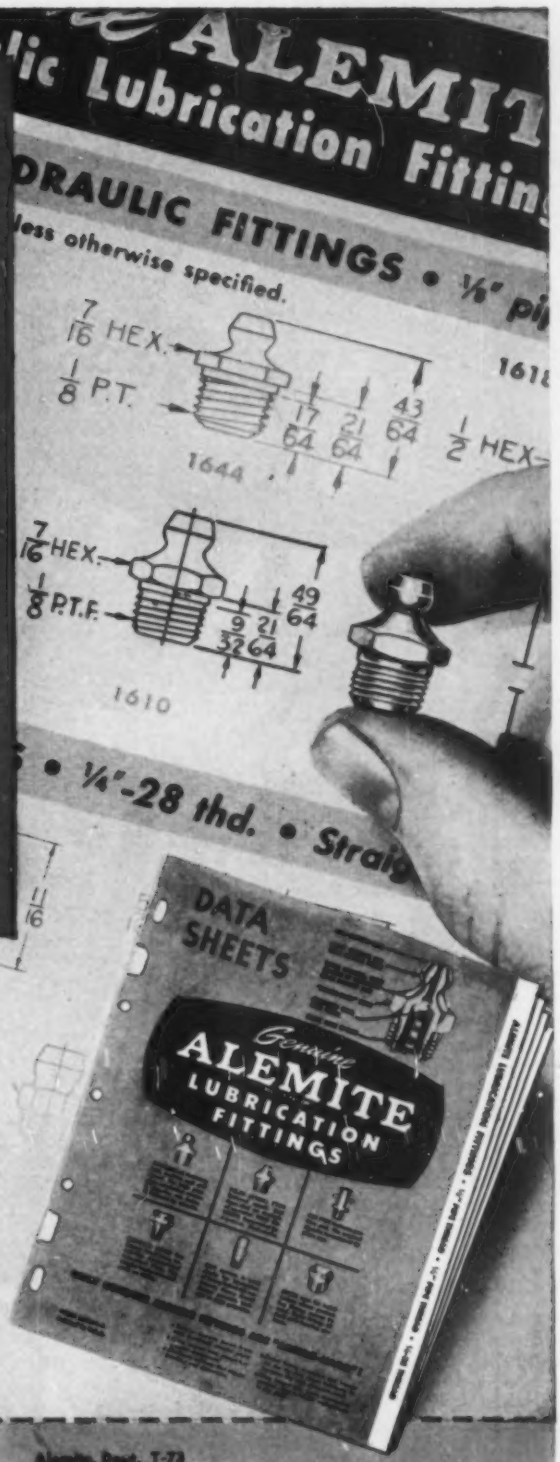

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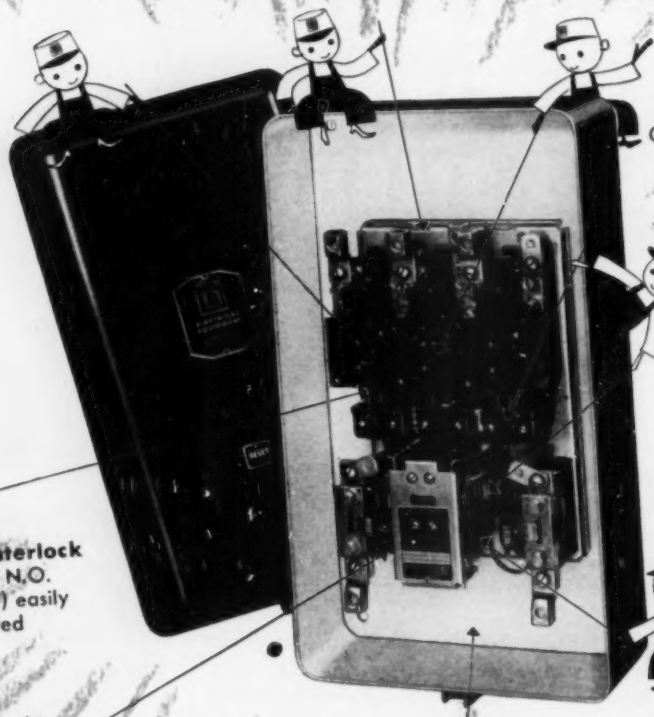

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Special sintered metal contacts last longer

High arc-interrupting capacity with "magnetic yoke" arc chamber

Coil and contacts removable from front **without disturbing power wiring**

Permanent air-gap lengthens magnet life

Up to 8 interlock circuits (4 N.O. and 4 N.C.) easily front-mounted

New coil holder simplifies coil change

All parts front-mounted for easy service and maintenance

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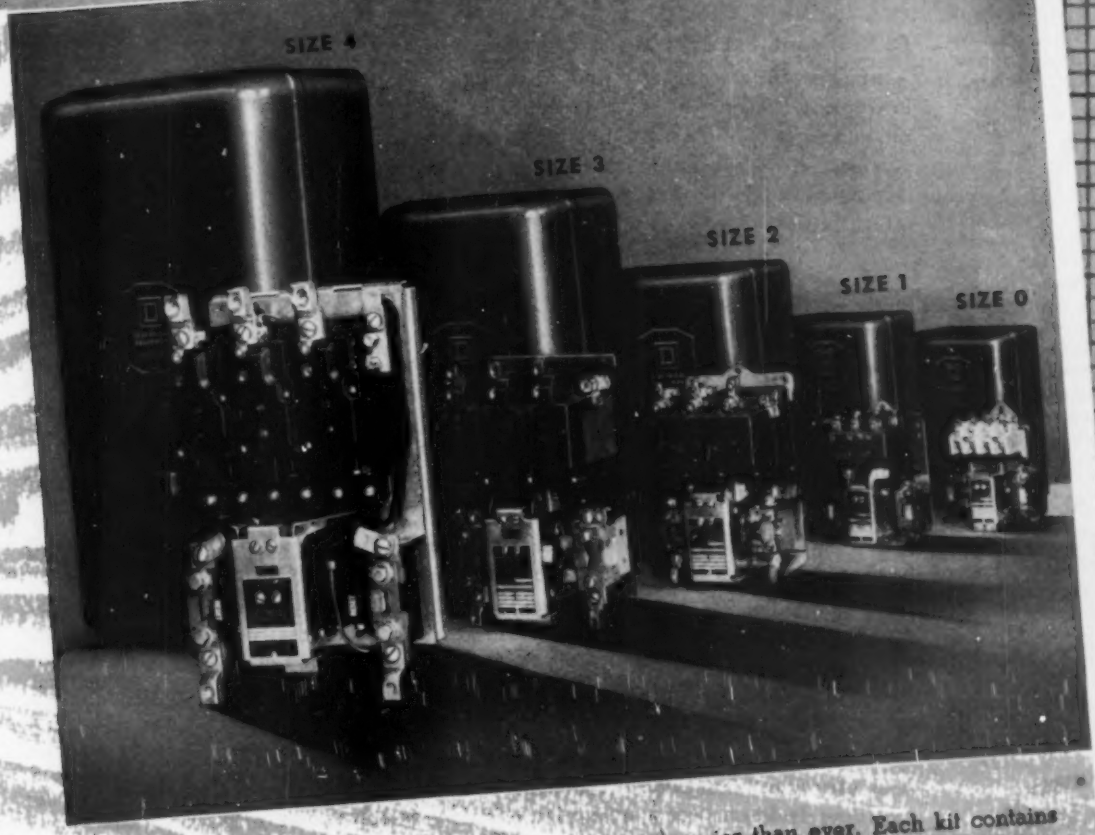
TO SQUARE D's *Design* MOTOR CONTROL



● The highest degree of accessibility, flexibility and compactness—with no sacrifice of performance and long life. That's Square D balanced design—and you'll find it in every size Square D starter.

"Off-the-Shelf" Parts Kits, another Square D convenience feature, make normal maintenance easier than ever. Each kit contains parts to replace all load contacts and finger springs. Electrical interlocks also available in kit form.

• • •

Write for Bulletin 8536, Square D Company
4041 North Richards St., Milwaukee 12, Wisconsin

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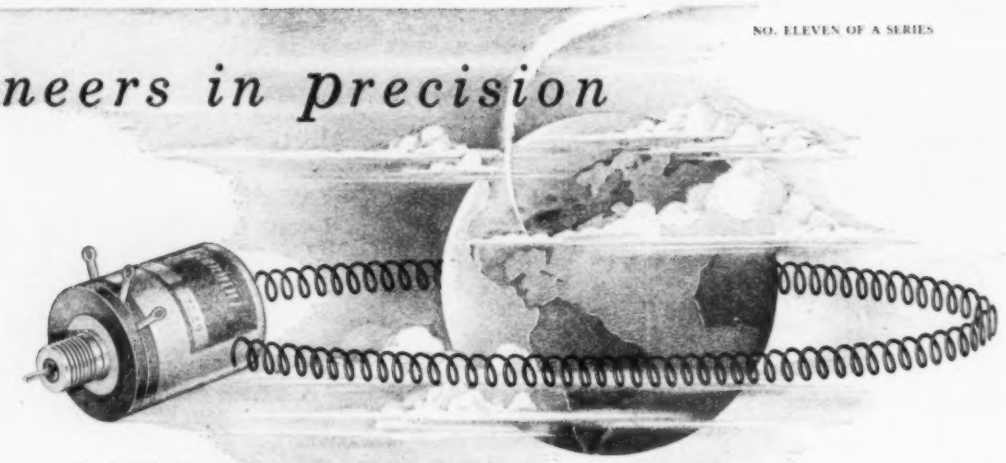

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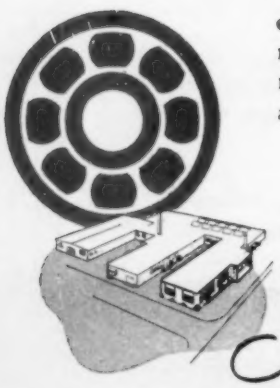

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Sealing News & Tips

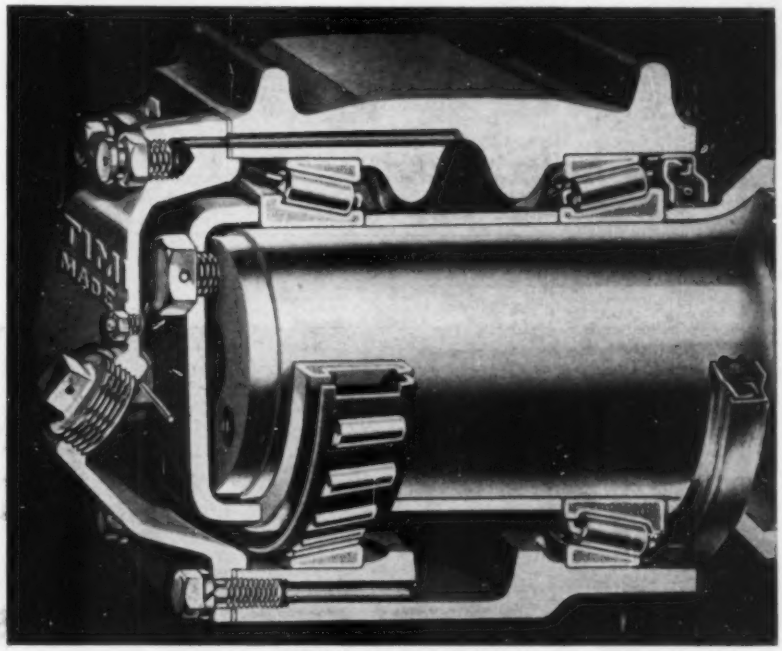

Fig. 1. Timken railway journal box

Special convoluted dual lip Syntech* seal designed for Timken railway roller bearing

Timken cartridge-type journal boxes for roller freight cars (Figure 1) employ a National Syntech seal to retain light bearing grease and exclude dirt, dust and water. This seal (Figure 2) has a convoluted sealing member of National Syntech (synthetic rubber), incorporating two opposed sealing lips tensioned by a middle-positioned spring. This design, plus the natural flex action of Syntech, insures uniform sealing under all operating conditions.

For maximum rigidity, durability and dimensional uniformity, the sealing lip is bonded to a steel member and assembled within a steel outer case. The case press fits into the Timken cartridge housing. A special requirement of the application is that the outer sealing lip must run dry on a 6.3" shaft, at speeds up to 1,000 r.p.m. A modified Syntech compound proves satisfactory for this demanding application.

National seals used in Timken railway bearing applications are specially designed to meet special conditions. In many sealing applications, however, one of 2,500 standard-design National Oil Seals can often be utilized. In either case, National Applications Engineers are at your service. Their special skills are backed up by the world's largest manufacturing facilities devoted exclusively to seals and 30 years of practical sealing experience.

Fig. 2. National Syntech Seal

*T.M. Reg.

National 50,000-S Syntech Seal

Standard-design National seal capable of continuous operation with zero leakage at intermittent temperatures to 300° F., speeds to 3,600 F.P.M., runout to .030 indicator. Precision-trimmed synthetic rubber sealing member is unaffected by water and most lubricants, detergents or industrial fluids.

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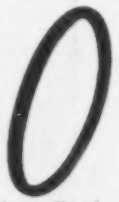

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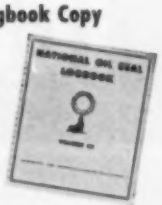

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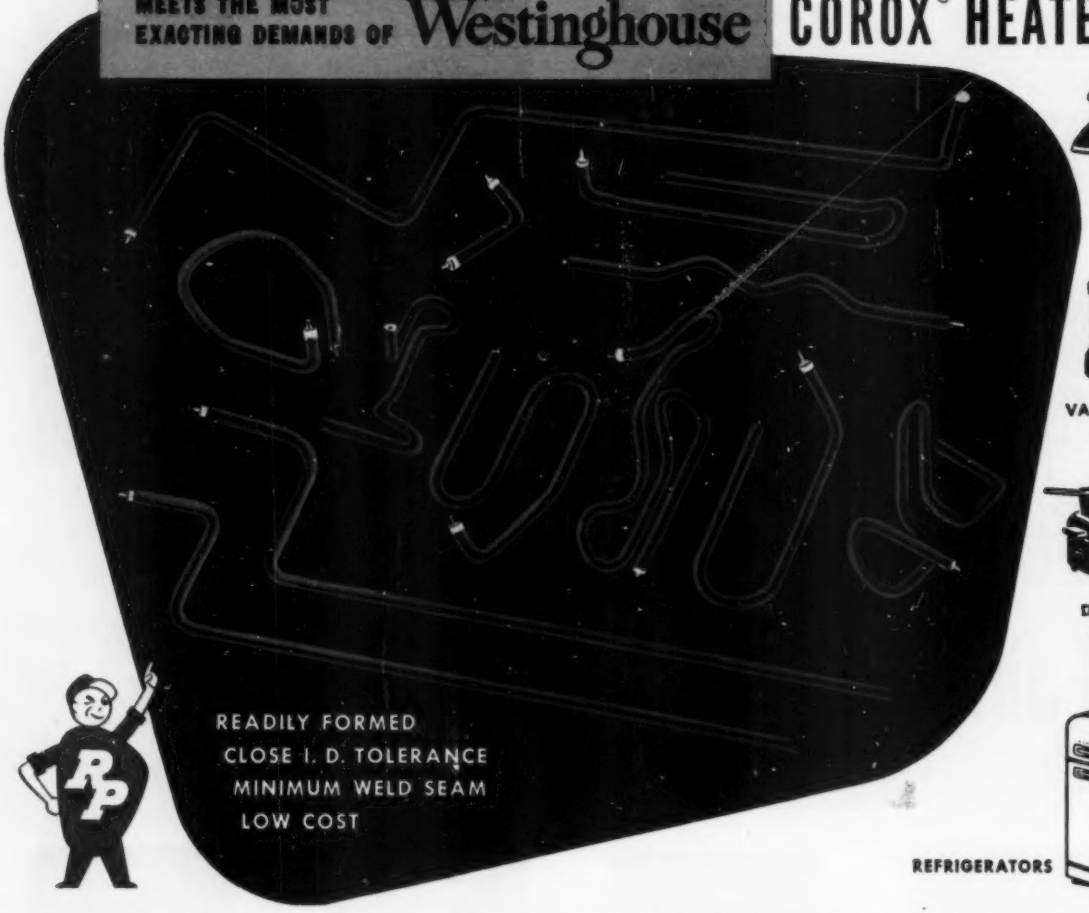

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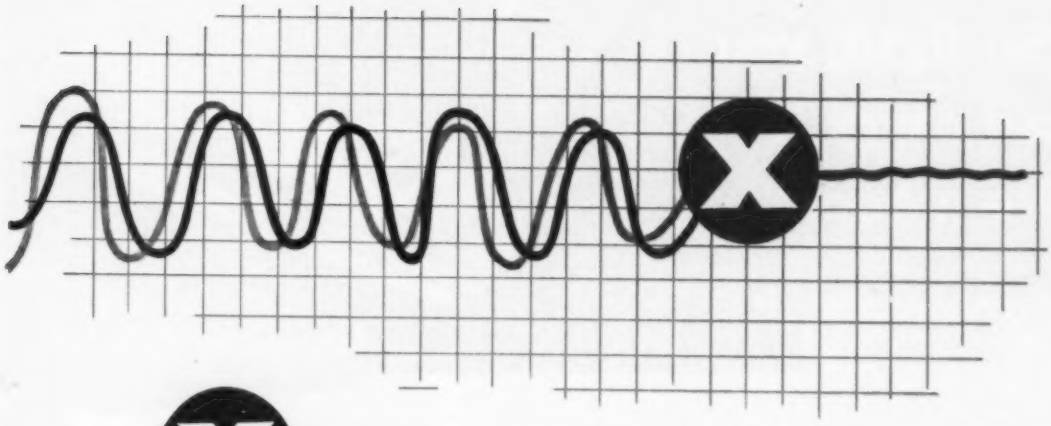

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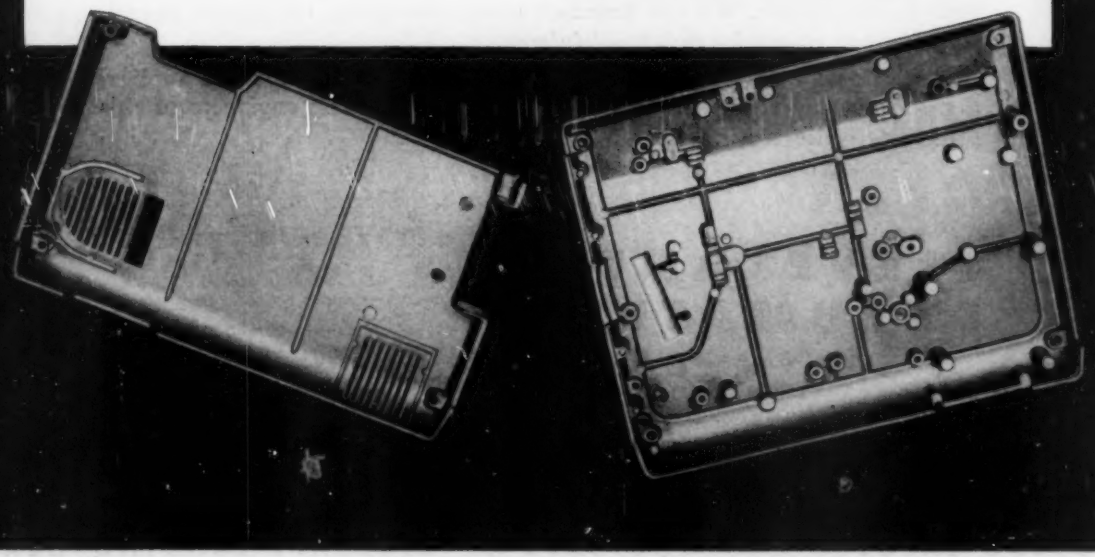

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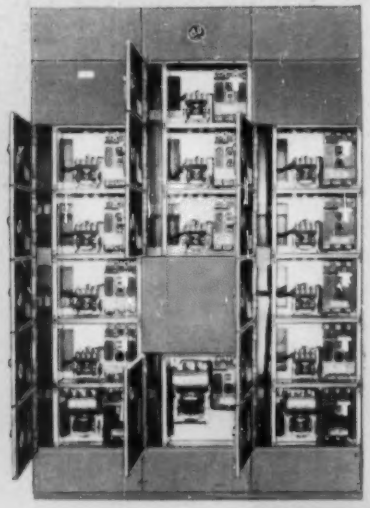

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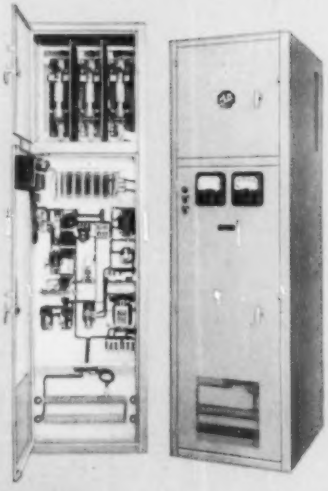

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TROUBLE FREE MOTOR CONTROLS

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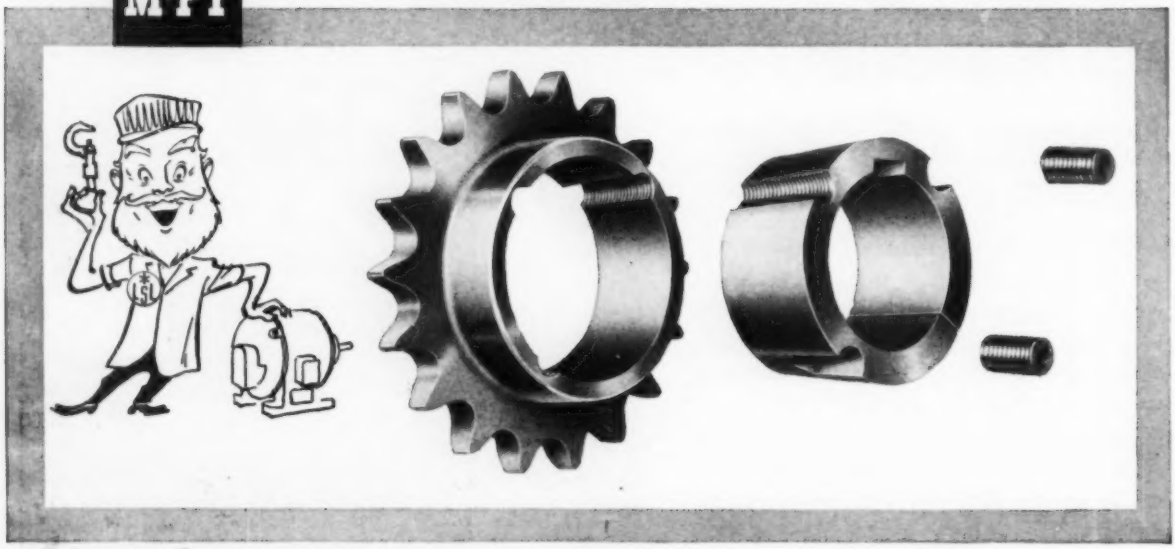

Now, practically every sprocket requirement you may have, can be filled from your local Morse Distributor's shelves.

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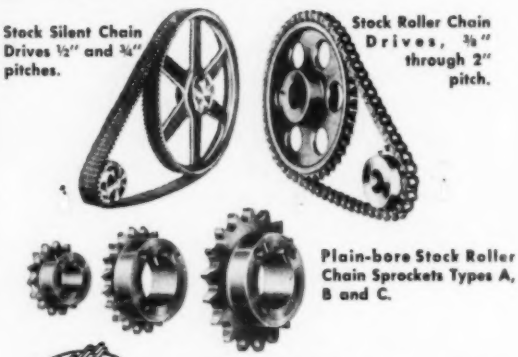
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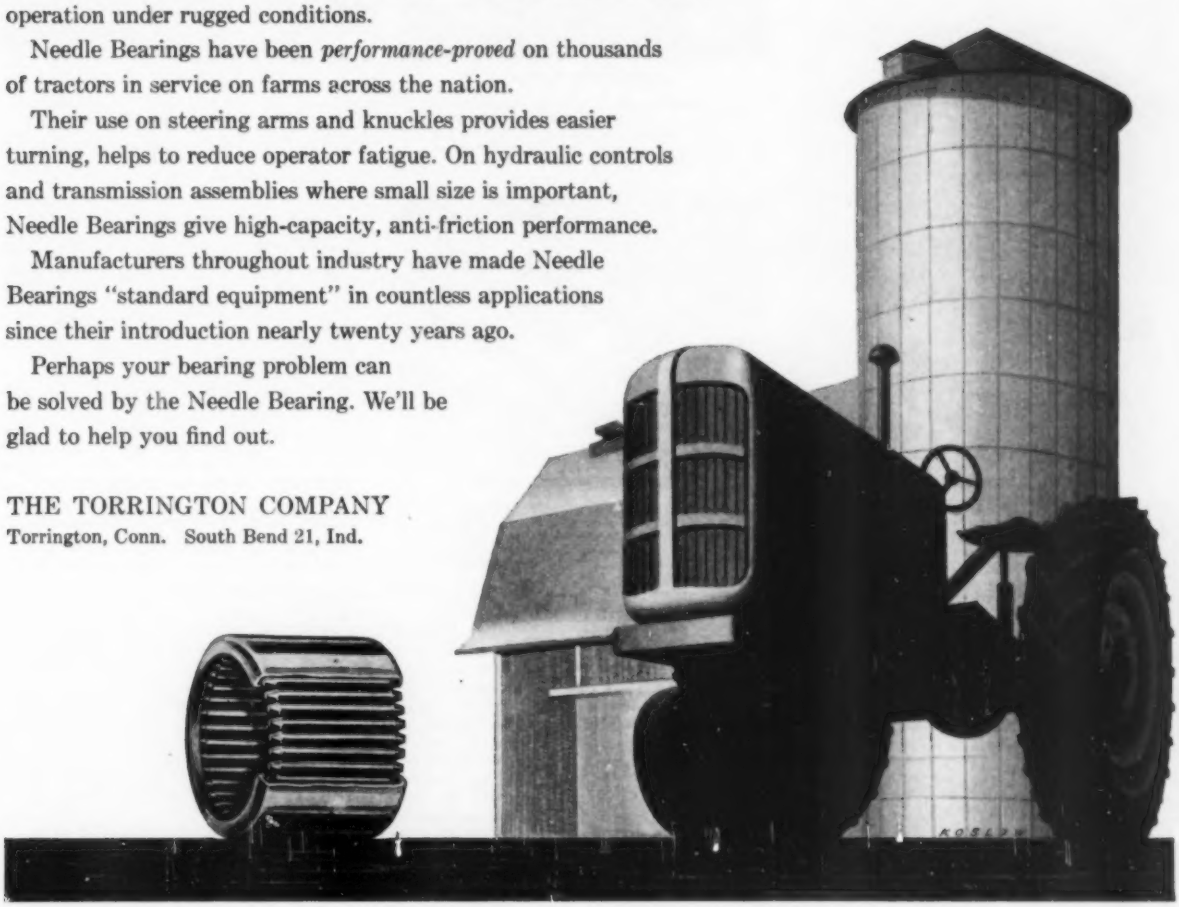

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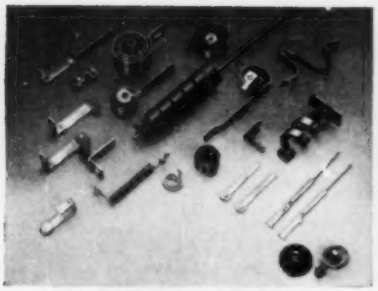

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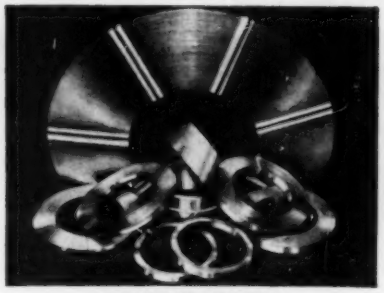

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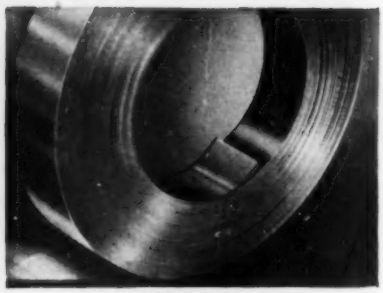

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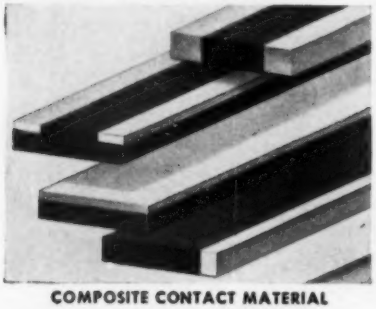

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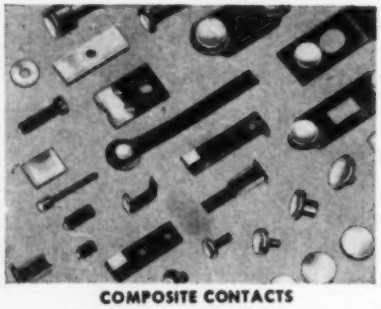

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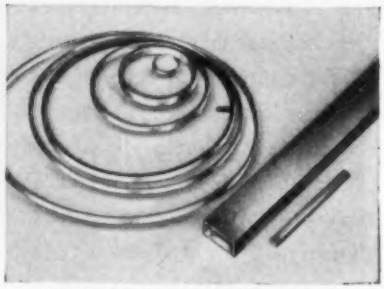

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- **Platinum-Group Metals** — Sheet, wire, tubing, parts of all types. Complete assay and refining facilities for platinum-group metals.
- **Silver and Gold Brazing Alloys** — Available as sheet, wire, powder and fabricated parts.
- **Bondwich** — Solder-clad brazing shim for carbide-tipped tools.
- **Bronco** — Phosphor Bronze-clad copper for high conductive springs.
- **Conflex** — Copper-clad spring steel for electrical and thermal conducive springs at low cost.
- **#720 Manganese Age-Hardening Alloy** — Corrosion resistant spring material for diaphragms, springs, finger stock, etc.
- **Rectangular Wave Guide Tubing** — Wide range of sizes to government specifications.

Write for catalog PR700

General Plate Composite Metals, made by metallurgically bonding one metal to another, are available in sheet, strip, tubing or wire in various widths, thicknesses and diameters.

Silver, gold and platinum-group metals bonded on base metals give solid precious metal performance at a fraction of the cost of solid precious metal. The precious metal provides specific performance requirements such as electrical conductivity and corrosion resistance while the base metal provides workability, strength, and solderability.

Composite base metals provide a new group of engineering metals with properties not available in solid metals. Their use frequently results in lower material costs as compared to solid metals.

In many applications further economy results when General Plate supplies fabricated parts ready for assembly into your product. General Plate makes an infinite variety of fabricated parts, such as electrical contacts, collector rings and TRUFLEX thermostat metal parts to customer's exact specifications.

General Plate Engineers will gladly help you with your problems.

You can profit by using General Plate Composite Metals!

METALS & CONTROLS CORPORATION
GENERAL PLATE DIVISION
17 FOREST STREET, ATTLEBORO, MASSACHUSETTS

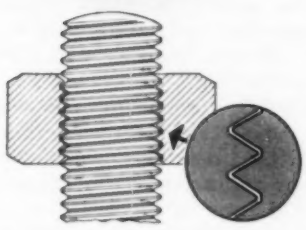
Elastic Stop nuts can't wobble

Formula for Failure—[(w) Initial thread wear + (e) bolt stretch + (s) thermal expansion or contraction + (α) wobble] × (v) vibration = a loose connection.

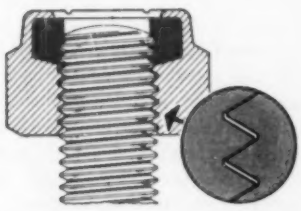
WOBBLE, permitted by normal axial thread play, and vibration are two of the major elements contributing to thread wear, loose connections and ultimate failure of a threaded fastener.

One device — the elastic locking insert — eliminates axial play and dampens destructive, wear-producing vibration. Because of the locking action of ESNA's famous red elastic collar, ELASTIC STOP nuts *do not loosen under vibration.*

Other important ESNA advantages include quick application and precise adjustment, reuseability, protection against liquid seepage, and uniform bolt loading. Mail our coupon for design information.



YOU CAN WOBBLE AN ORDINARY NUT AND BOLT with your fingers. This is the result of the tolerance spread permitted by the several classes of thread fit.



GRIPPING THE BOLT WITH A PERFECT FIT, ESNA's red elastic collar enforces a constant downward pressure that eliminates axial play, enforcing a positive contact between load-carrying sides of bolt and nut threads.

ELASTIC STOP NUT CORPORATION OF AMERICA
also maker of the ROLLPIN

Elastic Stop Nut Corporation of America
Dept. N36-72, 2330 Vauxhall Road, Union, N. J.
Please send the following free fastening information:

☐ ELASTIC STOP nut bulletin

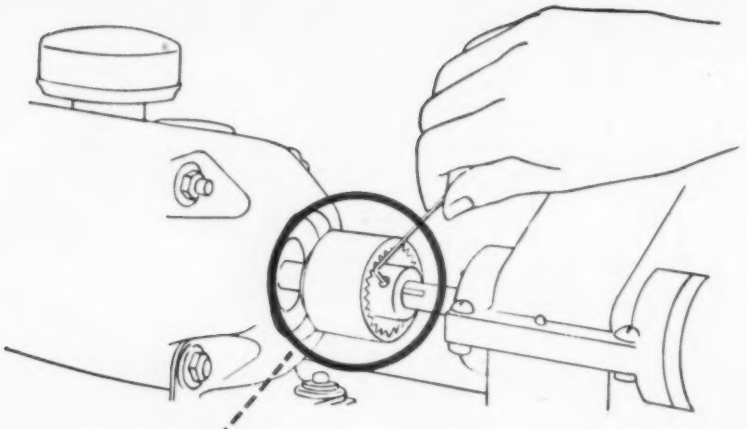
☐ Here is a drawing of our product. What self-locking fastener would you suggest?

Name_____ Title_____

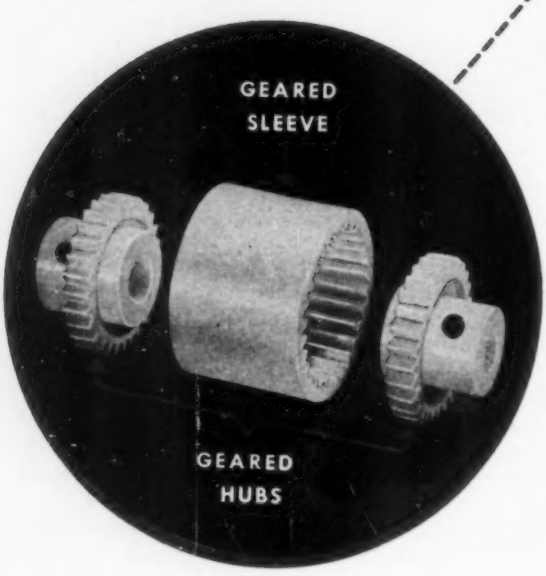
Street_____

City_____ Zone_____ State_____

Only ESNA manufactures a complete line of all types and sizes of self-locking nuts



Couplings of resilient DU PONT NYLON plastic



Couplings molded for
John Waldron Corporation,
New Brunswick, N. J.,
by Pyro Plastics, Union, N. J.

. . . run quietly at high speeds without oiling . . . resist wear . . . don't corrode

Severe operating conditions often cause excessive maintenance on small flexible gear couplings used to connect fractional horsepower motors and driven equipment—such as pumps and generators. Shaft misalignment results in noisy operation and excessive wear. Under certain conditions abrasion and corrosive attack can severely shorten service life.

The John Waldron Corporation has now developed an improved gear coupling that overcomes these problems. In this design, the three components—the internally geared "sleeve" and two externally geared "hubs"—are molded of Du Pont nylon plastic—one of the Du Pont family of plastic engineering materials.

Du Pont nylon is resilient. It damps noise and vibration . . . absorbs shock loads . . . assures quiet operation. Du Pont nylon is strong, tough, durable . . . resists wear and abrasion often with little or no lubrication. (Couplings operated without lubrication for over 18 months showed no appreciable wear). Du Pont nylon is unaffected by water, oils, most common chemicals . . . is not subject to rust or electrolytic corrosion. Du Pont nylon will operate continuously to 250°F. It provides electrical insulation. And parts of Du Pont nylon can be economically mass-produced by rapid injection molding—cutting production steps and costs.

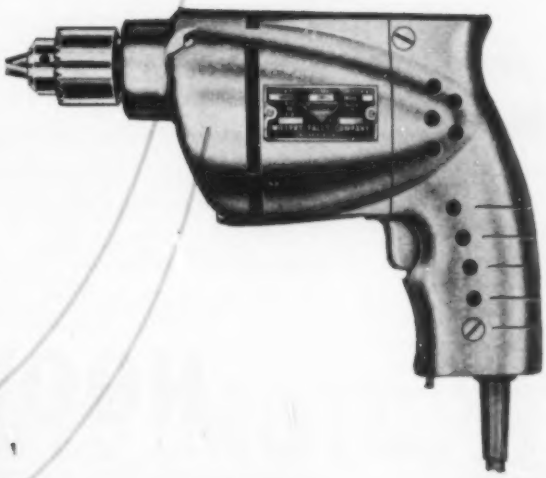
This is another of the hundreds of examples where Du Pont nylon plastic is contributing to improved performance in industrial parts. Perhaps it can be of value to you. For full information, write: E. I. du Pont de Nemours & Co. (Inc.), Polychemicals Department, Room 107 Du Pont Bldg., Wilmington 98, Delaware.

DU PONT
REG. U.S. PAT. OFF.
BETTER THINGS FOR BETTER LIVING
. . . THROUGH CHEMISTRY
Polychemicals
DEPARTMENT
PLASTICS • CHEMICALS

GRAMIX® BEARINGS help insure efficient operation of MILLERS FALLS Power Drills

There are many reasons why Millers Falls No. 912 ½-in. and No. 1814 ¼-in. Power Drills operate on GRAMIX bearings. GRAMIX bearings help absorb the thrust load and maintain alignment of the drill shafts. They help to insure efficient operation and long, dependable service. Having a porous structure which makes it possible to oil-impregnate them during manufacture, they provide a constant film of oil at the bearing surface for the life of the drills. The ten bearings in these two popular drills are typical of the hundreds of applications in which GRAMIX has improved performance and helped insure the useful life of the product.

• GRAMIX is compacted from powdered metals under pressures up to 70,000 psi., and sintered in high temperature furnaces to produce strong, tough bearings, gears and other parts that will usually out-perform and outlast similar machined parts. They can be formed in relatively complicated shapes to tolerances as close as .0003". GRAMIX parts need little or no machining, thus virtually eliminating scrap loss and waste. In production quantities, GRAMIX parts cost considerably less than machined parts.



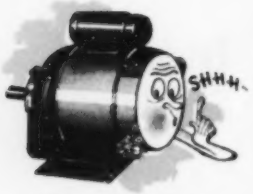
GRAMIX CATALOG FREE

The new GRAMIX *Catalog is full of facts and figures, charts and data that show how you can save money and improve the performance of your products with* GRAMIX *parts. Write for it today.*

97

THE UNITED STATES GRAPHITE COMPANY

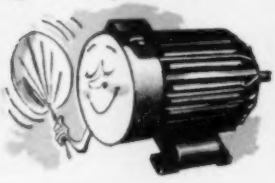
DIVISION OF THE WICKES CORPORATION • SAGINAW, MICHIGAN



HOOVERS ARE

QUIET

Smooth, vibrationless operation helps keep plant noise-levels low. Ideal for fans and other air-moving equipment—for general shop use.



HOOVERS ARE

COOL

No friction, no lag, no drag. Designed to be fully self-cooling as they run. Drip-proof. Fan cooled and convector-fan cooled models.

HOOVERS ARE

CLEAN

. . . and easy to *keep clean*. Perfect for food-industries machinery. No blind passages to collect dirt. Open and fully enclosed types.

HOOVERS ARE

POWERFUL

With starting torque to spin hard-to-start machinery—running torque to carry a varying load at uniform speeds. Ruggedly built to give years of trouble-free operation.

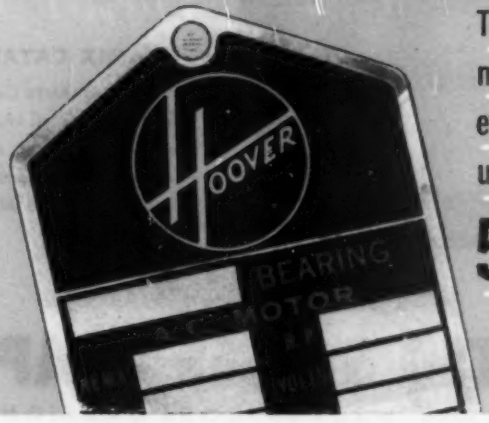
more H.P. in less space

You don't need a motor as "big as a horse" to deliver all the horsepower you need. Hoovers are designed to do a big job in a small amount of working space.

The same precision engineering and precision manufacturing that gives you more horsepower per pound and per cubic-inch of space means more motor for the money, too. Hoovers run cool and quiet, with uniform torques. They've got what it takes to stand up under the grind of continuous operating cycles and the punishment of frequent starts and stops under heavy loads.

And service—when it's needed, where it's needed! Hoover's service facilities are world-wide—always ready to protect your customers and to guard your good name.

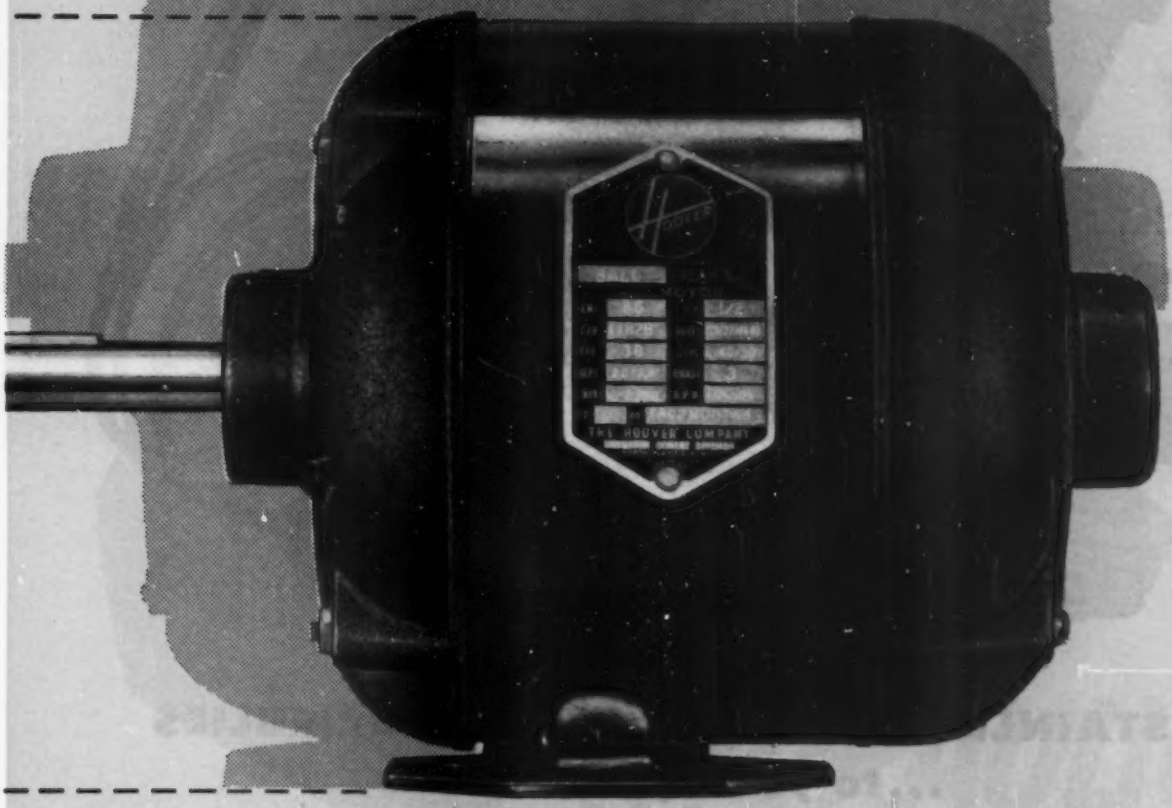
HOOVER HEAVY-



The right motor for every power need up to

5 H.P.

Compare the space-saving compactness of this Hoover General Purpose Motor with a typical motor of the same h. p.



DUTY ELECTRIC MOTORS

The full line of in-production Hoover Motors includes types suitable for almost any industrial requirement. Motors with special mechanical or electrical characteristics can usually be tailored to your specifications. Call in a Hoover Sales Engineer to work with your design engineer, or fill out coupon for further information.

The Hoover Company
Electric Motor Division
78 Brook Avenue
North Plainfield, N. J.

Please send me additional information on Hoover motors suitable for use on the following applications: _____

_____

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Name _____

Firm Name _____

City _____ Zone _____ State _____

STAINLESS STEEL BELLOWS ASSEMBLIES

...to your specifications

THE BELLOWS ASSEMBLIES pictured here give you an idea of the many types we make—and we can give you more ideas that can make savings on *your* bellows assemblies requirements. For example, we will work with you to develop an assembly exactly suited to your needs. That's a specialty with us—has been for half-a-century. Then—our skilled personnel and ample facilities can relieve you of all production problems and worries. You save time, trouble and money.

If you need bellows assemblies for thermostatic devices . . . flexible connectors . . . expansion joints . . . pressure controls . . . hydraulic mechanisms or for other uses—we can help you. Write for helpful technical advice. Ask for idea-filled Catalog NP-1200.

FULTON SYLPHON
DIVISION
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EVERYTHING'S UNDER CONTROL

TEMPERATURE CONTROLS • BELLOWS ASSEMBLIES • BELLOWS DEVICES

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Eaton Permanent Mold Gray Iron Castings—

for HYDRAULIC CONTROLS

Send for your free copy of the 32-page illustrated booklet: "The Eaton Permanent Mold Foundry." It tells the story of Permanent Mold Castings and takes you on a picture-tour of the Eaton Foundry at Vassar, Michigan.

EATON MANUFACTURING COMPANY
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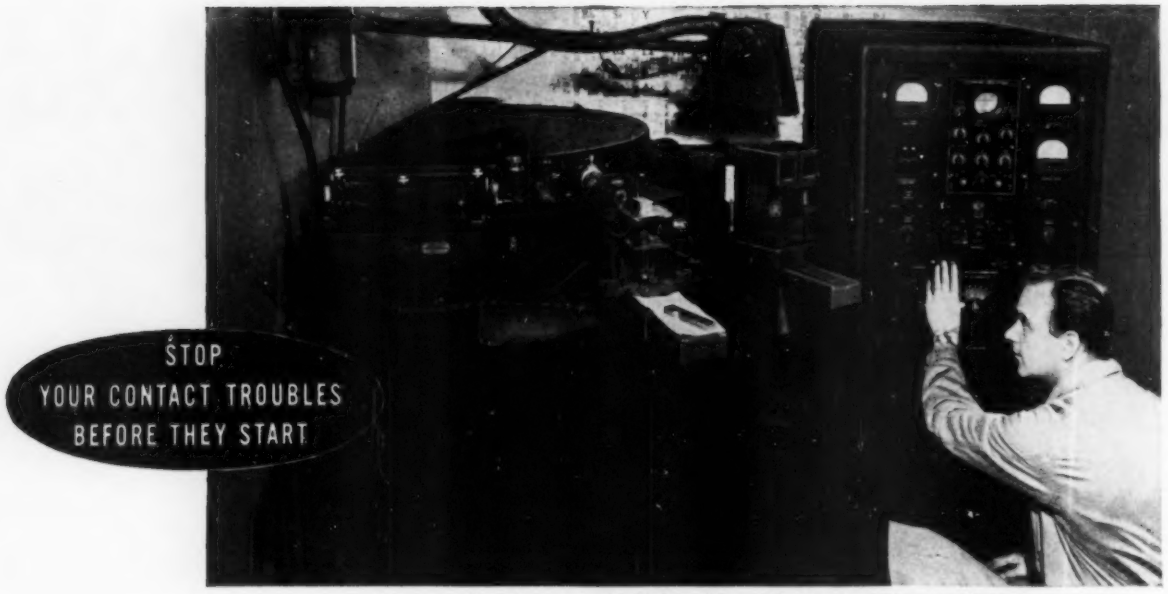
PRODUCTS: Sodium Cooled, Poppet, and Free Valves • Tappets • Hydraulic Valve Lifters • Valve Seat Inserts • Jet Engine Parts • Rotor Pumps • Motor Truck Axles • Permanent Mold Gray Iron Castings • Heater-Defroster Units • Snap Rings Springtites®-Spring Washers® Cold Drawn Steel • Stampings • Leaf and Coil Springs • Dynamatic Drives, Brakes, Dynamometers



Spectrograph equipment in the Mallory Contact Engineering Laboratory for analyzing the composition of metals and alloys used in electrical contacts.

To A Concentration of .0001%

Mallory quality control includes spectrographic analysis of contact metals and alloys.

At Mallory, performance and long life for the contacts in your products start in the laboratory where a spectrograph and densitometer give fast accurate answers to the composition of metals and alloys.

This equipment is used regularly in production quality control as well as in new material development and trouble shooting. It is a positive means of identifying any contamination or impurity that might reduce contact efficiency.

Mallory is equipped with complete laboratory, engineering and production facilities to handle any contact requirement —from simple button or rivet contacts to complex contact assemblies.

Mallory engineers have had years of experience in the design and production of over 5000 different types of contacts and contact assemblies. We are ready for your call.

Expect more . . . Get more from **MALLORY**

In Canada, made and sold by Johnson Matthey and Mallory, Ltd., 110 Industry Street, Toronto 15, Ontario

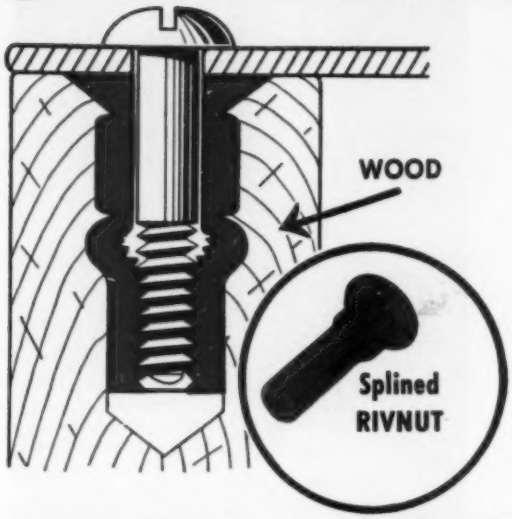
Electrical Contacts and Contact Assemblies

P.R. MALLORY & CO Inc.
MALLORY

SERVING INDUSTRY WITH THESE PRODUCTS:
Electromechanical—Resistors • Switches • Television Tuners • Vibrators
Electrochemical—Capacitors • Rectifiers • Mercury Batteries
Metallurgical—Contacts • Special Metals and Ceramics • Welding Materials

P. R. MALLORY & CO. INC., INDIANAPOLIS 6, INDIANA

B. F. Goodrich RIVNUT set in wood gives 6 clean threads for fastening

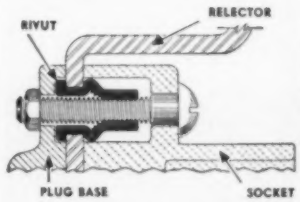


B. F. GOODRICH RIVNUTS eliminate use of wood screws where their frequent removal quickly wears away the wood. Imbedded and upset in wood, a BFG Rivnut provides at least six clean threads for screw attachment. Bulge formed by upsetting with easy-to-use heading tools holds Rivnut fast. Splined shaft or key in Rivnut head provides needed torque resistance.

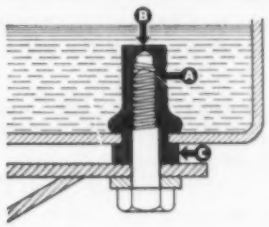
One manufacturer now uses splined Rivnuts to fasten the backs of television sets (see application at left). Screw holes in the cabinet were wearing too big from removal of wood screws.

The splined Rivnut is only one of many types of Rivnuts that solve tough fastening problems in wood, metal, plastic, many other materials. Rivnuts can be installed by *one* man from *one* side of the work in *two* seconds. They can be installed after enameling without marring finish. They save time, cut production costs, make products better. Consult a Rivnut engineer for help with *your* fastening problem. Write Dept. A-45 for complete information, or send coupon below. The B. F. Goodrich Company, Akron, Ohio.

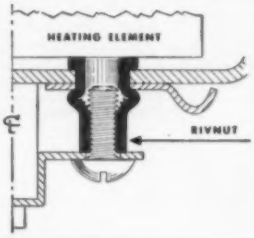
If you have fastening jobs like these, get B. F. Goodrich RIVNUTS



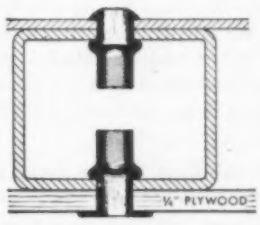
1. DOES 2 FASTENING JOBS! B. F. Goodrich Rivnuts fasten spotlight socket to reflector; same screws hold plug base to reflector. Former method demanded piercing, tapping, welding operations.



3. ELIMINATES BRAZING! Rivnuts with closed end (B) are installed in one-tenth the time it took to braze nut plates on oil reservoir tanks. Leaking, warping and thread cleaning are eliminated (A). Spacer head (C) positions tank.



2. ELIMINATES REINFORCING PLATE! In assembly of vaporizers, Rivnuts do away with reinforcing plate, don't turn under torque, hold flange securely without bending. Result: less assembly time, fewer parts, better product.



4. FASTENS PLYWOOD TO STEEL! Easier to install than wood or self-tapping screws, Rivnuts fasten plywood walls to tubular steel sections in trailers. No wood filler needed.

B.F.Goodrich
RIVNUT
The only one-piece blind rivet with threads

SEND NOW FOR FREE RIVNUT DEMONSTRATOR

Demonstrates with motion how Rivnuts work. Explains construction, gives proved applications.

THE B. F. GOODRICH COMPANY
Dept. A-45, Akron 18, Ohio

Name .....

Company ..... *Title* .....

Address .....

City ..... *Zone* ..... *State* .....

A blind rivet that may open your eyes

There may be a message for you in these pictures, even if you don't use rivets.

For maybe you have a product that isn't performing the way you want it to. And maybe your problem is to find the right metal.

The makers of "pop" rivets had just such a problem.

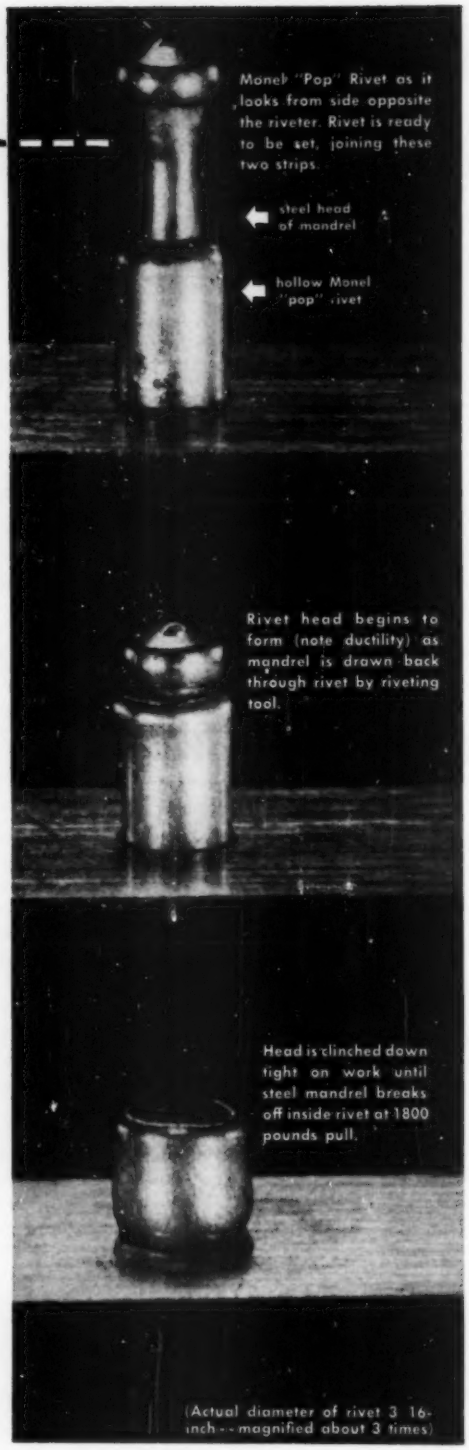
Here they'd come up with a wonderful idea for a blind fastening. The "pop" rivet lets you rivet tightly in blind corners and other confined places where you can only get to work on one side. And it's easy to use and does the job inexpensively. Still, the metal used wasn't quite right for every job . . .

First, they needed a metal that is strong enough to make a tight joint, even in thin gauge sheet metal. Yet the metal had to be ductile enough to form a tight-holding head when riveted. And it had to be able to resist corrosion by most acids, alkalies and many other corrosives.

After trying other metals, they found Monel® provided their answer. And the characteristics and the economy of Monel "pop" rivets make them a possible replacement for many non-blind fastenings as well, wherever a hollow Monel rivet can be used for N.P.A.-approved applications.

Perhaps this metal problem of the rivet makers brings one of your own to mind. And perhaps your solution, too, lies in Monel, or another metal in the Inco Nickel Alloy family. The quickest, easiest way to find out is to write us. All our problem-solving services are yours for the asking. The International Nickel Company, Inc., 67 Wall Street, New York 5, N. Y.

"Pop" Rivets, long known as "Tucker Blind Rivets" in Great Britain, are now being produced in this country by J. C. RHODES & COMPANY, branch of UNITED SHOE MACHINERY CORPORATION, New Bedford, Mass.


Monel "Pop" Rivet as it looks from side opposite the riveter. Rivet is ready to be set, joining these two strips.
steel head of mandrel
hollow Monel "pop" rivet
Rivet head begins to form (note ductility) as mandrel is drawn back through rivet by riveting tool.
Head is clinched down tight on work until steel mandrel breaks off inside rivet at 1800 pounds pull.
(Actual diameter of rivet 3 16-inch--magnified about 3 times)

Inco Nickel Alloys

INCO

Monel® • "R"® Monel • "K"® Monel • "KR"® Monel • "S"® Monel • Inconel® • Inconel "X"® • Inconel "W"® • Incoloy® • Nimonic® Alloys • Nickel • Low Carbon Nickel • Duranickel®

Here's how to cash in a crippled motor for a fully guaranteed replacement

Through the Westinghouse Motor Exchange Plan, your company can release money tied up in stand-by motors and renewal parts . . . money that can be profitably employed in your own production. Under a most unique service policy, Westinghouse has set up a motor replacement pool for crippled motors. This Motor Exchange Plan makes available to you an immediate, fully guaranteed replacement for single or three-phase Life-Line* motors, under 20 hp, in frame sizes 203 to 326.

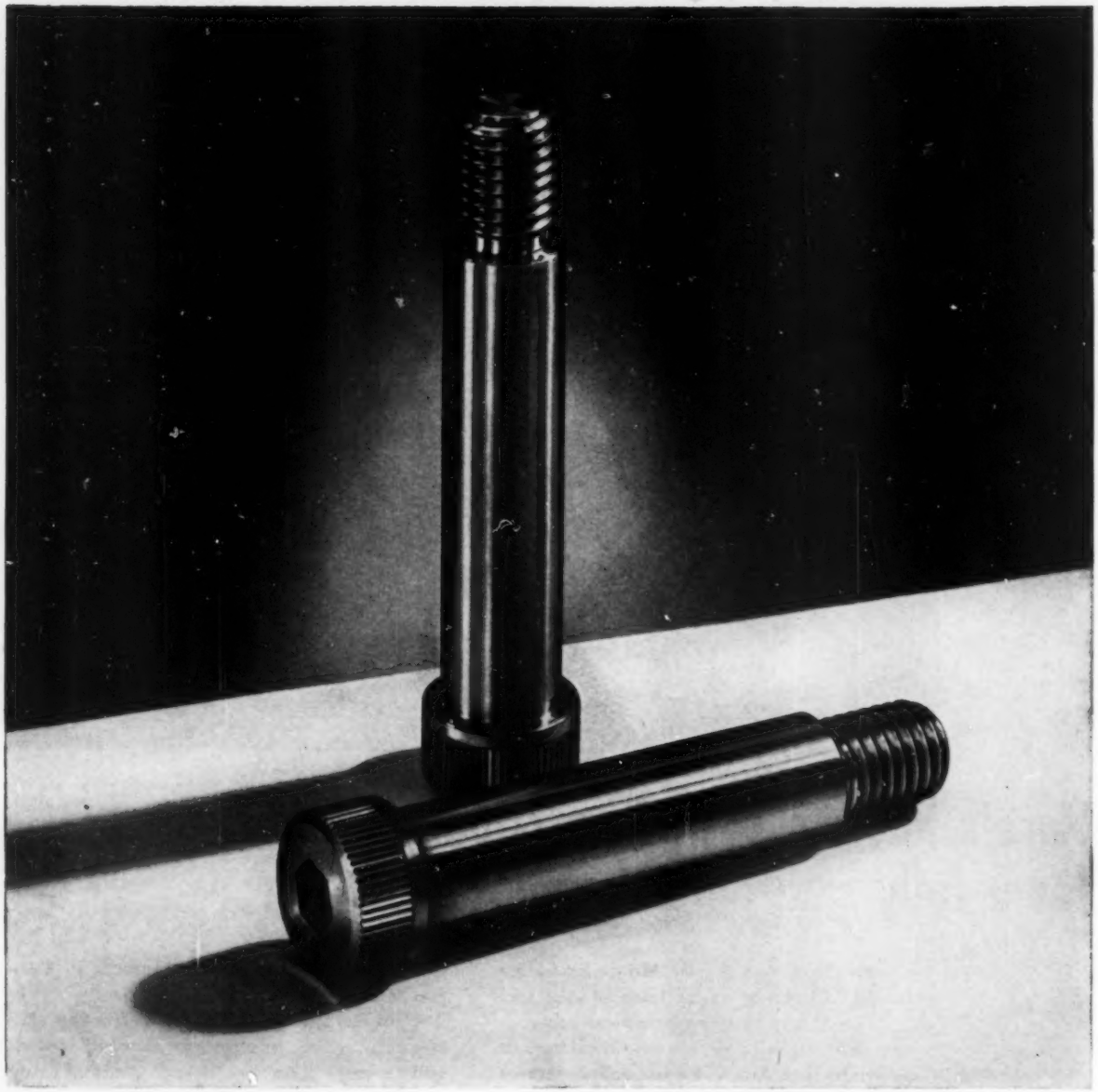
Quick over-the-counter replacement of Life-Line motors is handled at exchange points in 127 key manufacturing and production centers. If you are not located near such a warehouse, your local Westinghouse Sales Office will gladly expedite shipment of a replacement motor to your plant.

With fast service of this kind, you can substantially reduce or eliminate stand-by motors and renewal parts. You'll find, too, that using the Motor Exchange Plan will release maintenance, labor and equipment, necessary for repairing motor damage, to work on more important jobs.

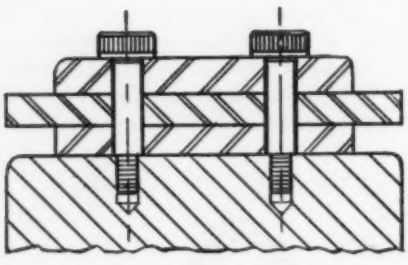
Investigate the Motor Exchange Plan soon with your local Westinghouse Salesman. He will leave with you a complete description of the plan contained in this pamphlet, SM-5243; or write today for this information, Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-21743

*Trade Mark

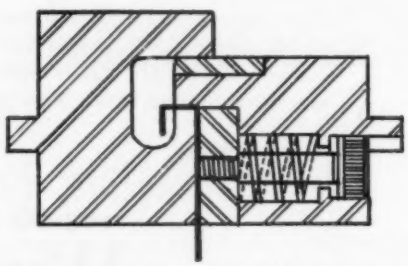
YOU CAN BE SURE...IF IT'S Westinghouse



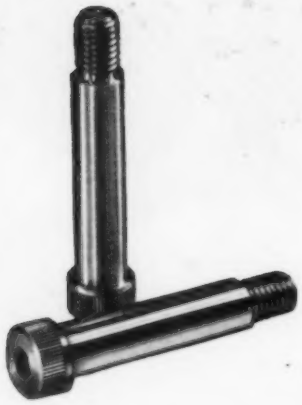
UNBRAKO SHOULDER SCREWS have these features: heat treated alloy steel for strength; knurled head for sure finger grip, fast assembly; accurate hex socket for positive internal wrenching; shoulders held to unusually close tolerances; threads and head concentric with body for uniformly accurate assembly; finished threads close to shoulder; fully formed threads, Class 3 fit; standard sizes, ¼" to ¾" in a full range of lengths.



As stationary guides, moving shafts or pivots.



For pressure pad and stripper plate applications.



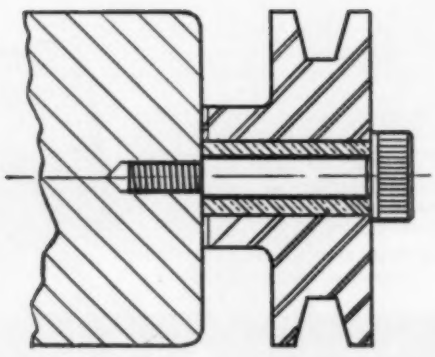
Save time and money, use UNBRAKO standards

Modern methods and quality control produce standardized UNBRAKO socket screw products in large quantities at low cost. A nation-wide industrial distributor organization, which stocks UNBRAKO, assures you excellent service and prompt deliveries. Write for UNBRAKO Standards, a complete listing of standard products stocked by your local UNBRAKO distributor. SPS, Jenkintown 28, Pa.

UNBRAKO® SOCKET SCREW DIVISION

SPS JENKINTOWN PENNSYLVANIA

Stocked and sold by leading industrial distributors everywhere



As stationary shafts or pivots.

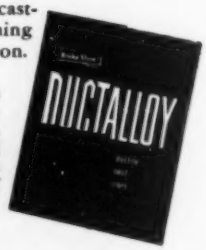
Write for UNBRAKO Standards

Ductalloy® castings make "impossible" parts producible

Wright J-65 jet engine main bearing support... impractical to machine from one piece. Readily produced as a weldment of two Ductalloy precision castings.

This highly stressed part secures the 7,200-lb. thrust Wright J-65 jet engine in the aircraft, carries major structural members ahead of and behind it, and mounts a main shaft bearing in its center. Air roars between the carefully contoured inner and outer rings.

As originally hogged out from an aluminum forging on an experimental basis, this part required some 1200 hours of machining—impractical for volume production. Redesigned by Curtiss-Wright Corporation's Wright Aeronautical Division as a weldment of two Ductalloy precision castings, it requires only simple turning and facing plus 25 ft. of welding to assemble the ten interconnecting stainless steel struts. An "impossible" part for volume manufacture in other metals which would meet specifications, it is rendered readily producible in Ductalloy—Brake Shoe's ductile cast iron that combines high strength with the casting and machining qualities of gray iron.



YOUR PROBLEM—Ductalloy may solve your problem if it involves economical production of complex metal shapes that are difficult to cast in steel, expensive to forge, or lacking strength in gray iron. Brake Shoe's experience, research laboratory and experimental foundry are available to help you best utilize its unusual combination of characteristics. Write for your copy of this new technical bulletin today.

Ductalloy castings are made by: BRAKE SHOE & CASTINGS DIVISION
ENGINEERED CASTINGS DIVISION

Brake Shoe

230 PARK AVENUE
NEW YORK 17 • NEW YORK

GET OUR *Free* 6-PAGE FOLDER

See where and how we mass-manufacture Small Gearing to uniformly fine tolerances. This attractively printed 8½ x 11" 6-page folder is punched for ring-binder use. You'll want to keep it handy for frequent reference. It contains 23 pictures of Small Gears, plant views, as well as Diametral and Circular Pitch Tables. Ask for your copy on company stationery, please!

Bears for Punishment

G.S.
Fractional Horsepower Gears

G. S. Gears can take *a lot of punishment!* They keep on serving smoothly, quietly, dependably long after ordinary Gears have broken down under the strain. Selection of correct materials . . extreme accuracy and above all *unvarying UNIFORMITY* in every one of a thousand gears or more, are some of the reasons for the finer quality of the Gears we make. If you too want small gears that can take it . . that will cut assembly downtime and improve your product, take advantage now of our 35 years of specializing in making better Fractional Horsepower Gears exclusively!

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GS

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SPURS • SPIRALS • HELICALS • BEVELS • INTERNALS
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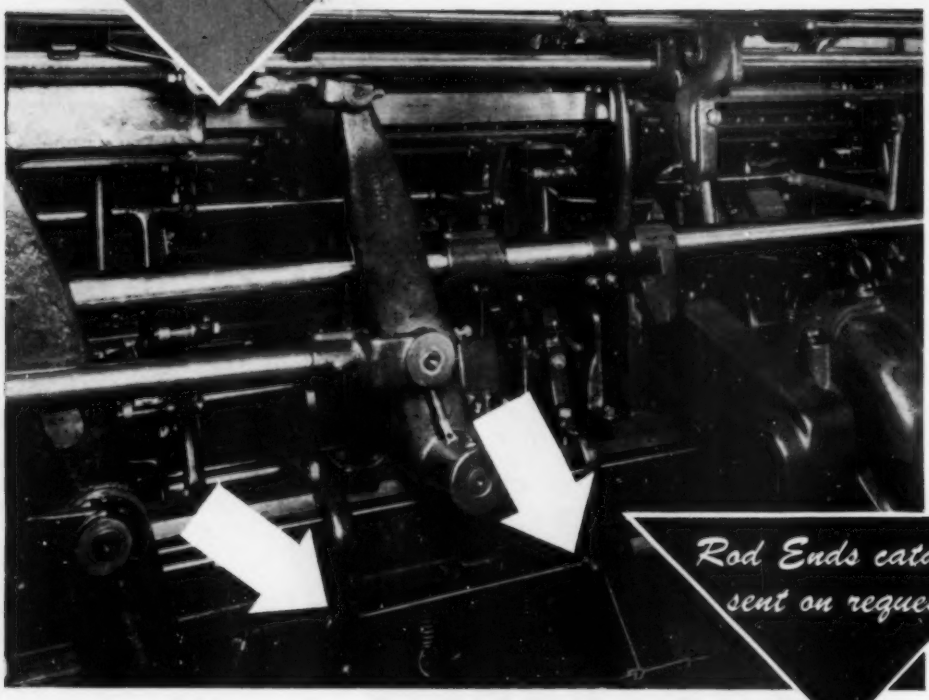
WORLD'S LARGEST EXCLUSIVE MANUFACTURERS
OF FRACTIONAL HORSEPOWER GEARING

HEIM ROD ENDS



SIMPLE APPLICATIONS OF HEIM SPHERICAL BEARING ROD ENDS CAN BE EXTREMELY IMPORTANT.

The actual use indicated in the above close up view is that of controlling automatic engagement and disengagement of the Covering Knife Motion on The Reading Full-Fashioned Knitting Machine, made by Textile Machine Works, Reading, Pa. The Heim Rod Ends form an important connecting link between a control unit on the front of the machine and an automatic operation device at the rear.

You can improve *your* linkage mechanism with Heim Spherical Bearing Rod Ends because they correct shaft misalignment. . . .

THE HEIM COMPANY, FAIRFIELD, CONN.

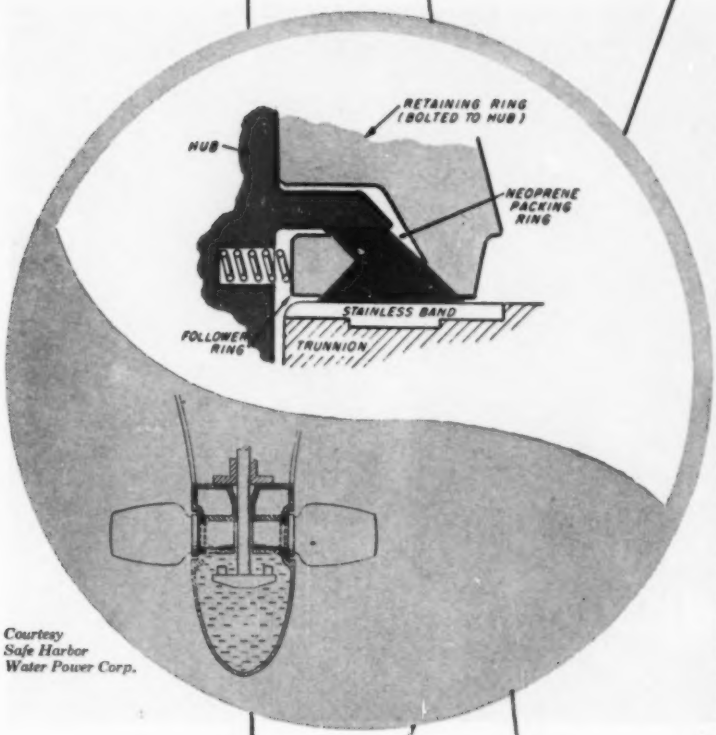
For the transmission of power at varying angles, use Heim Spherical Bearings and Rod Ends.

OIL RESISTANCE

ABRASION RESISTANCE

LOW COMPRESSION SET

These properties of neoprene make a better HYDROTURBINE



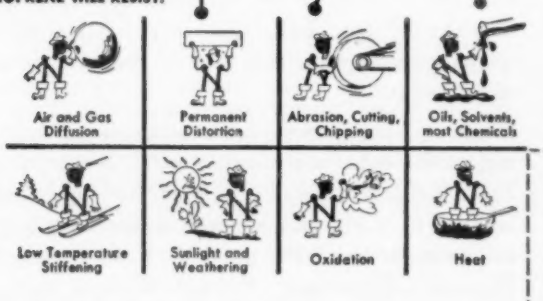
Courtesy Safe Harbor Water Power Corp.

One of the key parts in the design of a variable-pitch blade hydroturbine is a seal to prevent loss of lubricating oil *from* and water leakage *into* the oil-filled turbine hub (see sketch at lower left). The cross section (upper left) shows the details of this seal on a turbine at a large Pennsylvania hydroelectric plant.

Encircling each of the five-blade trunnions on this turbine is a neoprene packing ring held under pressure by a follower spring. As the blades change pitch, the ring presses against the hub and against a stainless steel band on each trunnion . . . keeps oil in and water out. Neoprene packing rings have been in service at this plant for more than ten years with no appreciable oil leakage. Oil leakage on some turbines previously amounted to 25 to 30 gallons per day.

This durable neoprene packing ring resists attack from oil and grease from the hub . . . stands up under constant abrasion from the rotating trunnion. And neoprene's low compression set means that the ring will retain its resilience despite continuous pressure. Properties like these explain why Du Pont neoprene so often provides the perfect solution to difficult problems in design.

PROPERLY COMPOUNDED NEOPRENE WILL RESIST:



DU PONT
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BETTER THINGS FOR BETTER LIVING . . . *THROUGH CHEMISTRY*

NEOPRENE

The rubber made by Du Pont since 1932

***FREE!* THE NEOPRENE NOTEBOOK**

Each issue shows new, unusual applications of neoprene . . . new products . . . improved designs. The neoprene application cited above is covered in detail in Notebook No. 50. Add your name to the mailing list today.

E. I. du Pont de Nemours & Co. (Inc.)
Rubber Chemicals Division PE-7, Wilmington 98, Del.

Name_____ Position_____

Firm_____

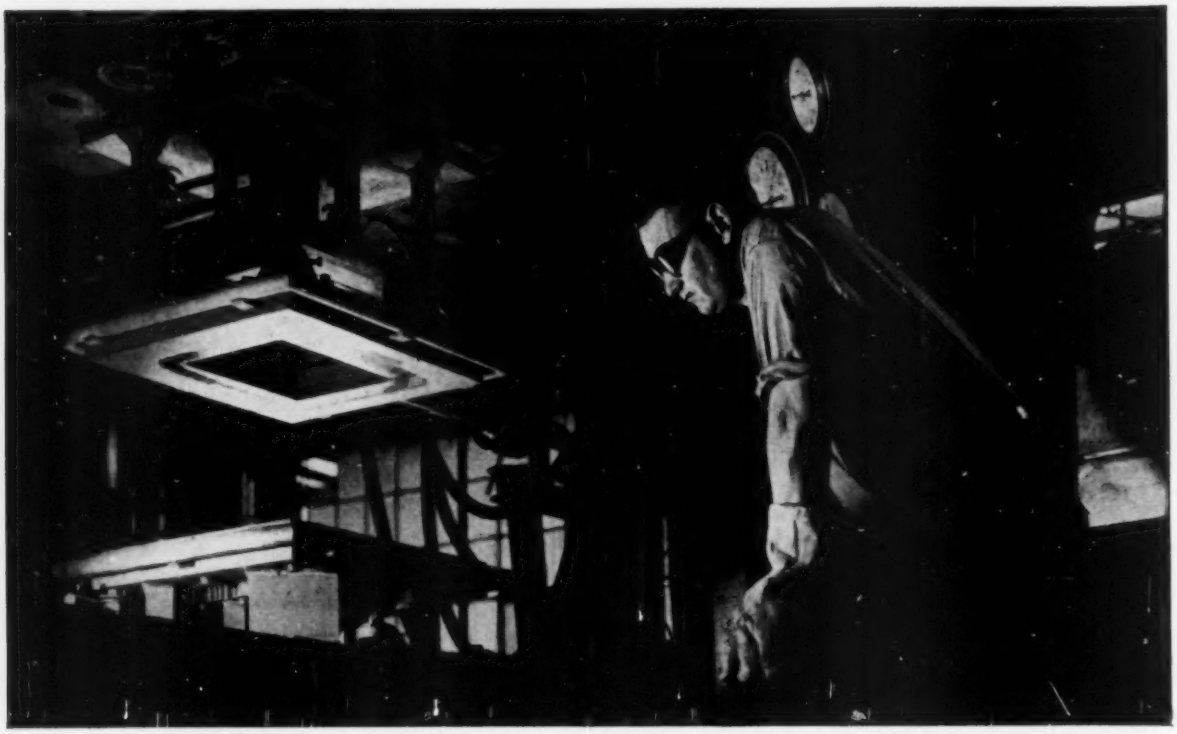
Address_____

City_____ State_____

DOW

DEEP DRAWS IN ONE OPERATION MADE POSSIBLE BY USE OF MAGNESIUM

Forming MAGNESIUM at elevated temperatures gives deeper draws which eliminate need for multiple die sets and repeated drawing



An outstanding advantage of magnesium is its deep-drawing properties at elevated temperatures. Compared to other metals, magnesium can be drawn from three to four times deeper in a single operation.

This often means the elimination of multiple sets of dies and repeated annealing and drawing. When designed in magnesium, parts can be drawn in one piece which in other metals could be economically fabricated only by joining separate pieces together.The result is a more pleasing design and a considerable saving in time and labor. It amounts to a considerable saving in cost, too.

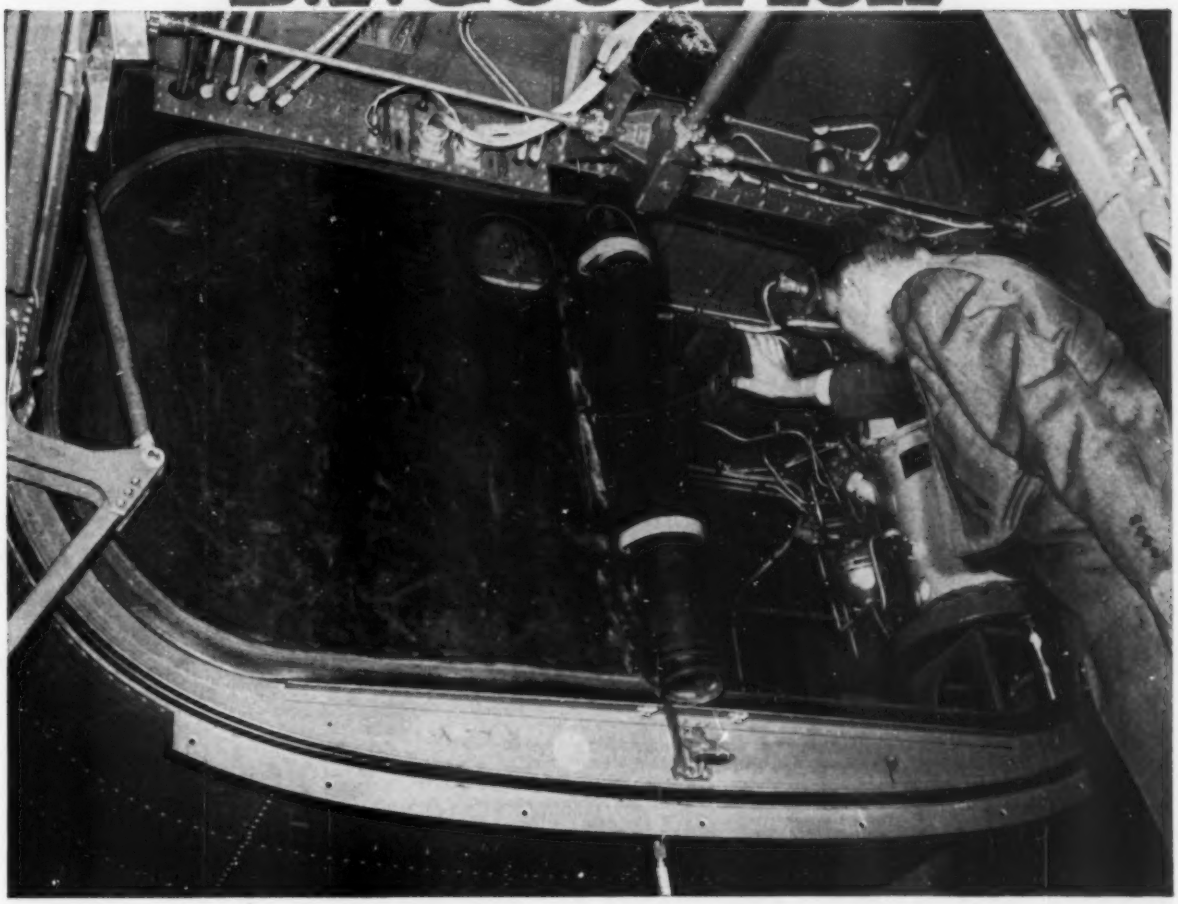
Generally, magnesium parts can be drawn to a depth of from 1½ to 2 times the minimum width of the blank in a single operation. Where a circular blank is used, the depth of draw in one operation can be twice the diameter of the blank. Also, hot forming reduces allowance for spring back to a minimum or actually eliminates it.

Whatever your fabrication methods, you will find that magnesium today is a practical metal. Add to that its functional advantages of light weight and high strength and you have a metal worth investigating. For further information, write to THE DOW CHEMICAL COMPANY, Magnesium Department, Midland, Michigan.

you can depend on DOW MAGNESIUM

DOW

B.F.Goodrich



New zipper seals tight, zips open fast

A NEW *KIND* OF SEAL keeps gases, liquids, dirt *in* or *out*. In the picture, it is used to seal a curtain that keeps fumes from an airplane's engines out of the forward compartment. Getting inside in a hurry was often as important as sealing out the fumes. Other methods of sealing called for screws or other fasteners. They took time to remove. The new B. F. Goodrich Sealing Zipper did both jobs—sealed tight, opened fast.

Here's how it works: Rubber lips are molded with hairline precision so that they fit together tightly. They press together even without pressure to seal effectively. And with pressure against the lips, the seal actually tightens. The rubber seal is applied to an ordinary zipper which zips open or shut in a hurry.

The B. F. Goodrich Sealing Zipper is so flexible it goes around curves and odd shapes where clamps won't work. Can be made of compounds to resist weather, oils, gasoline, chemicals. Can be sewn or cemented to fabric, metal, wood, glass. The rubber can be made to match any color. Production costs are often reduced because the zipper is so easy to install.

It has been used in life-saving suits, to seal delicate instruments against moisture, to seal lifeboats against sea water, to seal auto convertible tops against rain. Write for complete details, sending blueprints or specifications of your products to Dept. A-41 or send coupon below. The B. F. Goodrich Company, Zipper Division, Akron, Ohio.

B.F. Goodrich

Airtight, Watertight Sealing Zipper

OVERLAPPING RUBBER LIPS IN THIS CROSS SECTION SHOW HOW ZIPPER SEALS

Send Now for Free Folder

Gives case histories, design advantages, suggested uses.

The B. F. Goodrich Company
Dept. A-41, Akron 18, Ohio

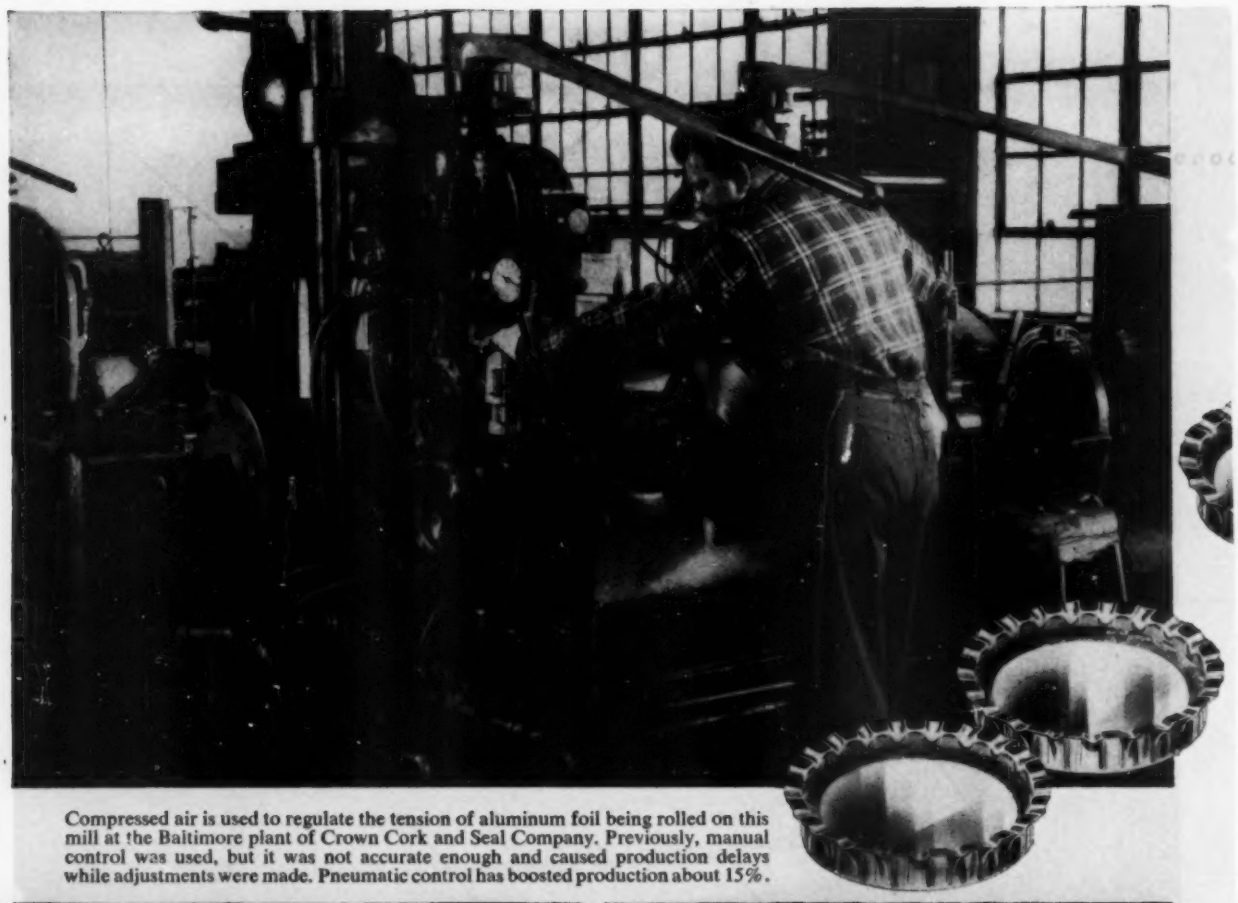
Name .....

Firm .....

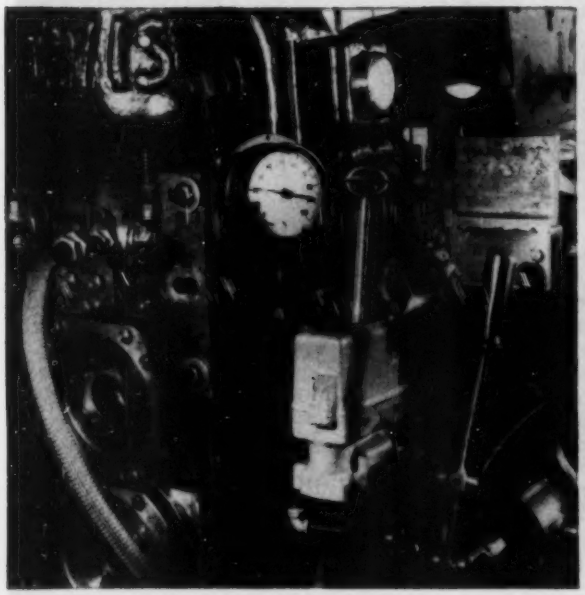
Title .....

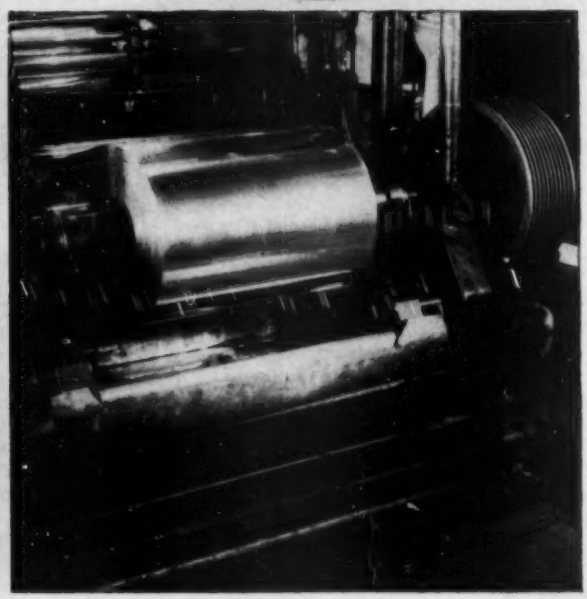
Address .....

City ..... *Zone* .... *State* .....



Compressed air is used to regulate the tension of aluminum foil being rolled on this mill at the Baltimore plant of Crown Cork and Seal Company. Previously, manual control was used, but it was not accurate enough and caused production delays while adjustments were made. Pneumatic control has boosted production about 15%.

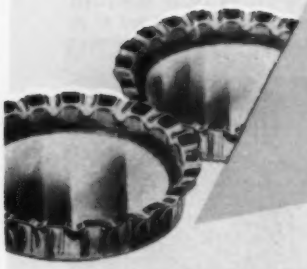




This simple valve . . . controls the tension of this feed roll

Tension is regulated by a pneumatic brake applied to the feed roll. Air pressure determines the amount of braking and is controlled by a Westinghouse Flexair® Valve. Once set, this valve automatically maintains the selected air pressure. The operator can position the valve just by moving his thumb. The great accuracy of this simple control enables Crown Cork and Seal Company to obtain a final thickness within plus or minus 10% of gauge. Scrap losses have been reduced 2% which quickly paid for the cost of the pneumatic control system.

Let AIR do the work



Three air valves, some pipe, and three brakes save 40,000 lbs. of aluminum a year

• You know those little protective discs of aluminum foil under many "Crown" bottle caps? At the big Baltimore, Maryland, plant of Crown Cork and Seal Company, the world's largest manufacturer of these caps, they roll and punch 2,000,000 lbs. of aluminum foil a year just to supply those discs.

It's precision rolling too. With a tolerance of only 1/10,000" on the final thickness. To maintain this hair-splitting accuracy, pneumatic tension control has been installed on all of Crown Cork and Seal Company's rolling mills. It replaces manual control.

Off-size scrap losses have been reduced at least 2%; that's 40,000 lbs. of aluminum a year. At the present price of foil, this saves *$18,000*—several times more than the cost of the pneumatic systems. In addition, production has been stepped up about 15%.

This simple pneumatic system, built around Westinghouse Air Brake controls, *automatically maintains* the correct air pressure. It has been operating 16 to 20 hours a day for the past year, and has proved to be completely reliable.

Our experienced engineers will be glad to help you design a pneumatic control system for your equipment. Just drop us a line.

Westinghouse Air Brake COMPANY

INDUSTRIAL PRODUCTS DIVISION **WILMERDING, PENNA.**

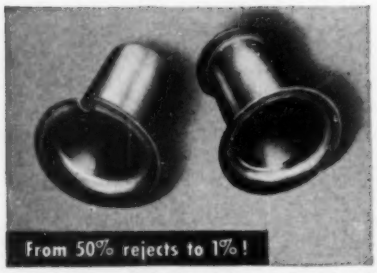
Factory Branch: Emeryville, Calif.
In Canada: Canadian Westinghouse Co. Ltd., Hamilton, Ontario

Where to use

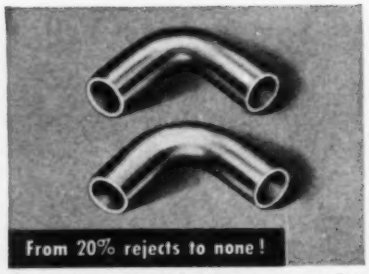
WESTINGHOUSE FLEXAIR® VALVES

There is a popular family of Flexair® Valves from which you can pick your requirements for pressure control. Along with their companion Controlair® Valves, they provide control of air pressure for pneumatic cylinders, actuators, clutches, and brakes. Combined with other Westinghouse pneumatic equipment they simplify control and speed up operation of diesel engines, hoists, cranes, and production machines.

We make an extensive line of industrial air compressors, cylinders, valves, chokes, filters, and other pneumatic devices.

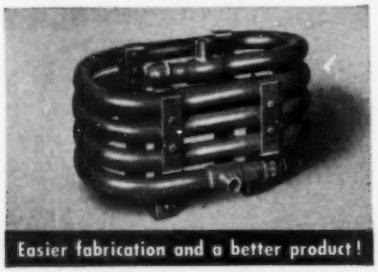


For this tough flaring job *two* brands of Stainless Tubing were tried with 50% rejects. Then they switched to Carpenter *and rejects dropped to less than 1%.*



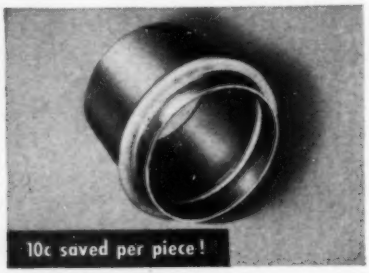
Rejects because of breakage amounted to 20% of each run. Changing to Carpenter Stainless Tubing, *rejects were completely eliminated.*

After making comparative tests, the maker of these bottle-filling units specified Carpenter Stainless Tubing *and saved 8c to 10c per unit.*



After testing tube from several sources, the manufacturer of these condensers found that Carpenter's quality control at the mill gave him easier bending and a better finished job.

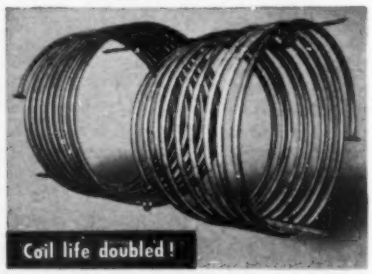
These thermostat sleeves and bulbs require precision fabrication. After changing to Carpenter Stainless Tubing they gained *a 15% to 20% saving in the cost of producing each unit.*



The fabricator of this refinery equipment needed a ductile Stainless Tubing that would "take" the severe fabrication. *Since changing to Carpenter, he figures a saving of about 10c apiece.*

That's why it pays to specify *Carpenter* Stainless Tubing!

Before changing to Carpenter, fabricating rejects ran 40%. Now the collapsible handle of this uranium detector is produced—at a reject rate of only 1%.



In a brick-lined hydrolysis tank, lead coils had been used for years. *Then they found that coil life could be doubled with Carpenter Stainless No. 20.*

These are only a few reports from hundreds in our files. They all add up to one important point: *All stainless tubing is not the same.*

Whenever the job calls for something "extra", users of stainless pipe and tubing in a wide variety of industries have come to know that they can depend on Carpenter quality and Carpenter technical assistance to meet the challenge.

It's a good idea to take your problems to Stainless Tubing and Pipe Headquarters. We'll take a personal interest in seeing that they are solved to your satisfaction. Distributors are located in principal cities from coast to coast. The Carpenter Steel Company, Alloy Tube Division, Union, N. J.

Export Dept.: The Carpenter Steel Co., Port Washington, N. Y. "CARSTEELCO"

Carpenter

STAINLESS TUBING & PIPE

Analysis · Tolerance · Finish

· guaranteed on every shipment

ALLIS-CHALMERS

PUMPS for Designers

Easy-to-Install pumps

Fit Most Designers' Needs

FHP pump

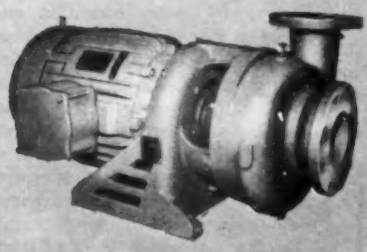
Up to 80 gpm, heads to 125 feet.

Compact pump and motor requires only two bolts for installation. Rigid construction holds alignment for longer bearing and seal life. Mechanical seal. Open impeller economy model does adequate job on many installations at very low cost. Closed impeller model for higher heads. Also available as frame-type pump for separate mounting.

Electrifugal pump

Up to 500 gpm, heads to 220 feet.

Only pump with unit-cast frame. Motor and pump are mounted on a single shaft in a one-piece rigid cast-iron frame. Alignment is rigidly held but there is plenty of space for maintenance. Installation requires only four bolts. Standard packing or mechanical seal available. Also built as frame-type pump for separate mounting.



Supporting adapter pump

Up to 2500 gpm, heads to 550 feet.

Flange motor and pump mounted on sturdy cast-iron supporting adapter. Motor and pump use same shaft. Rigidity assures vibrationless operation and long bearing life. Only four bolts required for installation. Available with standard packing or mechanical seal. Built in same ratings as frame-type pump for separate mounting.

FREE ENGINEERING HELP

YOUR ALLIS-CHALMERS PUMP REPRESENTATIVE is thoroughly familiar with the pump problems of equipment designers. He can offer you valuable time and money-saving suggestions in planning your equipment.

When you need help on a pump problem, call your nearby Allis-Chalmers District Office. Write Allis-Chalmers, Milwaukee 1, Wisconsin for Bulletins 52B7529, 52B6140 and 52B6083 describing these designers' pumps.

A-3969

Electrifugal is an Allis-Chalmers trademark.

ALLIS-CHALMERS

BRIDGEPORT BRASS COMPANY

COPPER ALLOY BULLETIN

Bridgeport Brass Co. MILLS IN BRIDGEPORT, CONN. AND INDIANAPOLIS, IND.—IN CANADA: NORANDA COPPER AND BRASS LIMITED, MONTREAL

A variety of automatic screw machine parts which illustrate forming, drilling, threading, knurling, and milling. Courtesy Seymour Brass Turnings Company, Seymour, Connecticut.

Achieving Higher Productivity

Yet Maintaining Accuracy and Good Finish

Higher productivity is the goal of screw machine operators to offset as much as possible rising labor and material costs.

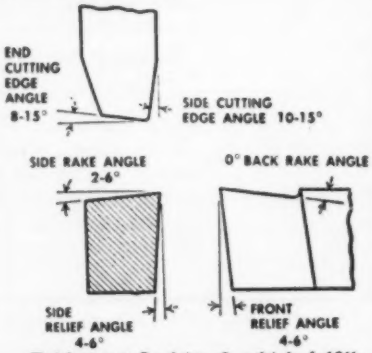
It is recognized that ancient, worn-out equipment in crowded quarters result in high cost, poor working conditions and low productivity. To attain higher productivity, the following factors should be considered:

1. Up-to-date machines — fast and sturdy.
2. Well-designed tools that perform with maximum efficiency and tool life.
3. Fast-cutting brass rod—accurate in dimensions and uniform in quality.
4. Proper coolant-lubricants.
5. Well-arranged layout in a good building.

Turning

On copper alloys the larger portion of forming operations are performed by circular, dovetail or flat tools. Turning and drilling or reaming can be done simultaneously. On exceedingly close tolerance work, drilling can sometimes cause variations in the size of the part. However, in other cases, drilling will tend to support the work.

Tools for cutting metal with a machinability rating between 70 and 100 per cent, require very little rake, as illustrated below.


END CUTTING EDGE ANGLE 8-15°
SIDE CUTTING EDGE ANGLE 10-15°
SIDE RAKE ANGLE 2-6°
0° BACK RAKE ANGLE
SIDE RELIEF ANGLE 4-6°
FRONT RELIEF ANGLE 4-6°

Bridgeport Ledrite 6, which fulfills at least 90 per cent of requirements, has a 100 per cent machinability rating. It contains 61% copper, 3.4% lead, remainder zinc.

Ledrite 2 Medium Leaded, machinability rating of 90 per cent (65% copper, 1.8% lead, remainder zinc) was developed for excellent machinability plus cold working as required for roll threading, knurling, forming and expanding.

Accuracy

Accuracy is maintained by elimination of mechanical faults, and in many cases its loss can be attributed directly to too much heat generated through friction. Sharp tools of proper hardness are imperative in attempting to hold accurate sizes. However, the removal of chips is an important factor. If the tool is not cutting cleanly, the increased pressure between the work and the tool forces the work away from the tool and at the same time thrusts the carriage back. This condition normally accounts for oversize parts.

Undersized dimensions are generally caused by excessive heat. Vibration in thin, long work pieces or in the tool or machine itself, will lead to variation in dimensions. Lighter cuts will generally reduce this vibration. Rigidity of the brass rod permits better shape and accuracy in the finished part, in other words, better quality control.

Finish

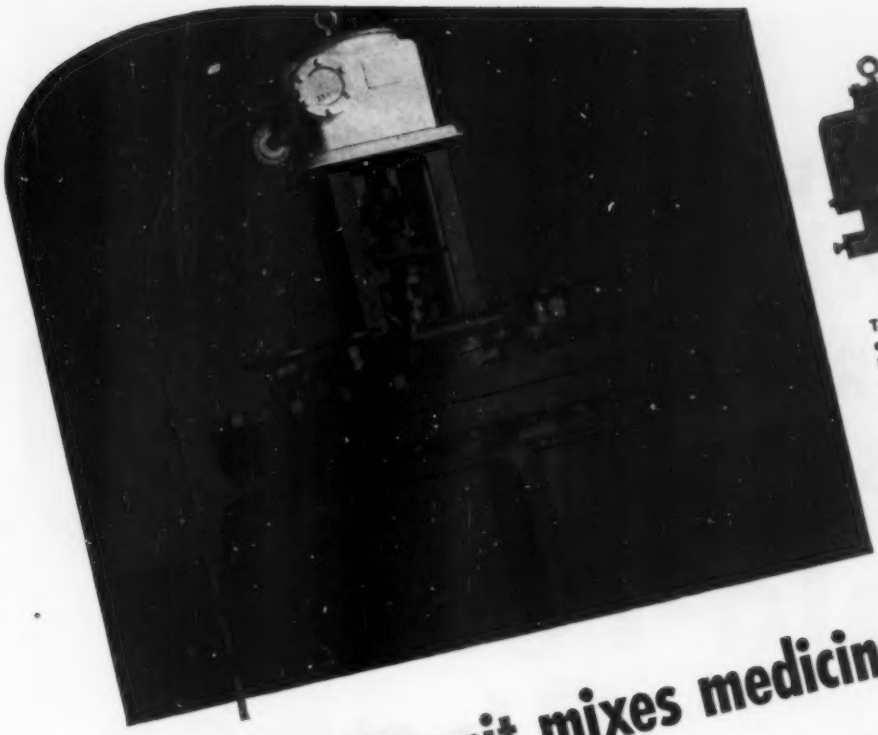
A good finish should be obtained with the first cut if possible, eliminating two operations, viz., roughing and finishing cuts. Finish is affected by practically every condition encountered in machining. Dull tools are the most common cause of poor finish.

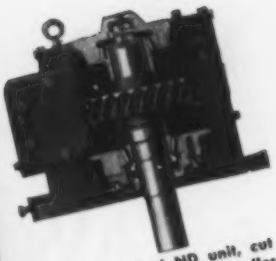
Better finishes, in many cases, can be obtained through carefully ground and polished cutting surfaces, the use of higher surface speeds and slower feeds. Minimum rake angles apply to free turning brass rod. However, the condition of the machine—play in the spindle, rigidity in the tool posts and ways—and the type of lubricant affect the finish considerably.

When the front clearance is too small, the burnished or bumpy surface and increased heat through friction instantly reveal the source of trouble. If the finish cut is heavy, high rake and clearance angles cause hogging in and chattering by permitting the tool to vibrate, even though slightly.

Write for Bridgeport's "Technical Handbook" for the physical and mechanical properties of standard rod alloys and other mill products. Please contact the nearest Bridgeport sales office for your metal requirements.

(9958)





The Cleveland ND unit, cut away to show tapered roller bearings on gear shaft, positive face-type oil seal, piston type lubricating pump and oil drain at base of housing.

At left—Cleveland size 50 ND unit on pressure mixing tank built by C. E. Howard Corporation, South Gate, Calif.

Space-saving ND unit mixes medicines smoothly

NOW at work in the production laboratories of a large drug company, this Howard pressurized, stainless steel agitator handles thousands of gallons of medicinal liquids. Smooth, efficient mixing is assured by the powerful drive—a Cleveland worm gear speed reducer mounted on the tank.

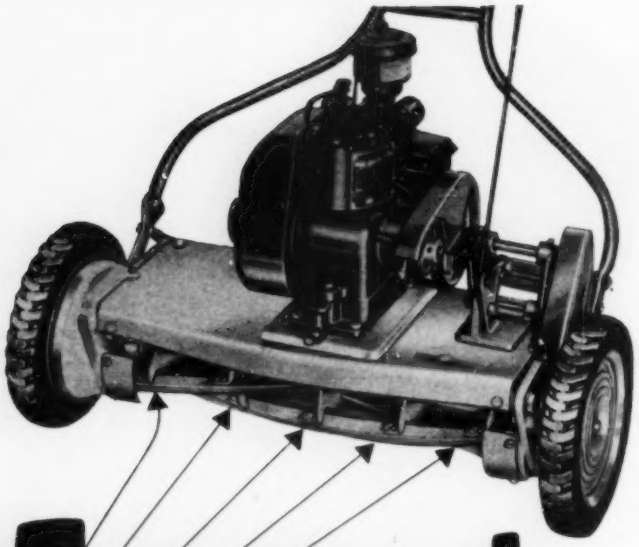
Heart of the Cleveland worm gear speed reducer is a case hardened steel worm operating on a low friction bronze gear. Materials, design and workmanship combine to provide year-after-year dependability under severest operating conditions. Easily installed on old as well as new equipment, Clevelands are known throughout the chemical and associated industries as the long-wearing reliable drive.

The ND drive shown here and its companion NU unit (drive shaft upward) are available in seven sizes each. For complete descriptions, capacity charts and other engineering data on these space-saving, powerful Clevelands, write today for free new Catalog 400. The Cleveland Worm & Gear Company, 3279 East 80th Street, Cleveland 4, Ohio.

Affiliate: The Farval Corporation, Centralized Systems of Lubrication. In Canada: Peacock Brothers Limited.

CLEVELAND
Worm Gear
Speed Reducers

HOW A MAKER OF LAWN MOWERS USES Cold-Formed Shapes



Five strong cutter heads help guide the knife blades on this fine power mower. They keep the blades aligned and provide the extra strength required for tough mowing.

These cold-formed shapes also provide something extra for the manufacturer. Because they're supplied to exact dimensions, without any waste material, they are easy to assemble. Relatively free of scale and roughness, they are riveted to the cutter blades quickly and easily, without extensive preparation.

No matter what you manufacture, the chances are good that you could use Bethlehem Cold-Formed Shapes in your product. Applications of these versatile shapes are almost limitless—lately we've made them for use in overhead doors, sign posts, bus bodies, storage racks, and lawn furniture, to name only a few. These and other shapes are made from strip, sheet, or plate steel, from 5 to 24 gage. A rough sketch will enable our engineers to determine whether we can make a practical, economical cold-formed shape for you.

We'll be glad to have our representative visit your shop and discuss the possibilities of using Bethlehem Cold-Formed Shapes in your product. Just phone or write the nearest Bethlehem sales office, or, if you prefer, get in touch with us at Bethlehem, Pa.

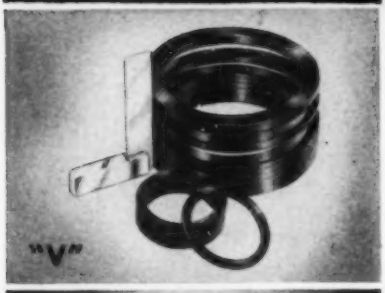
BETHLEHEM STEEL

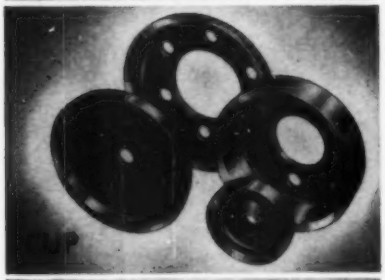
BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

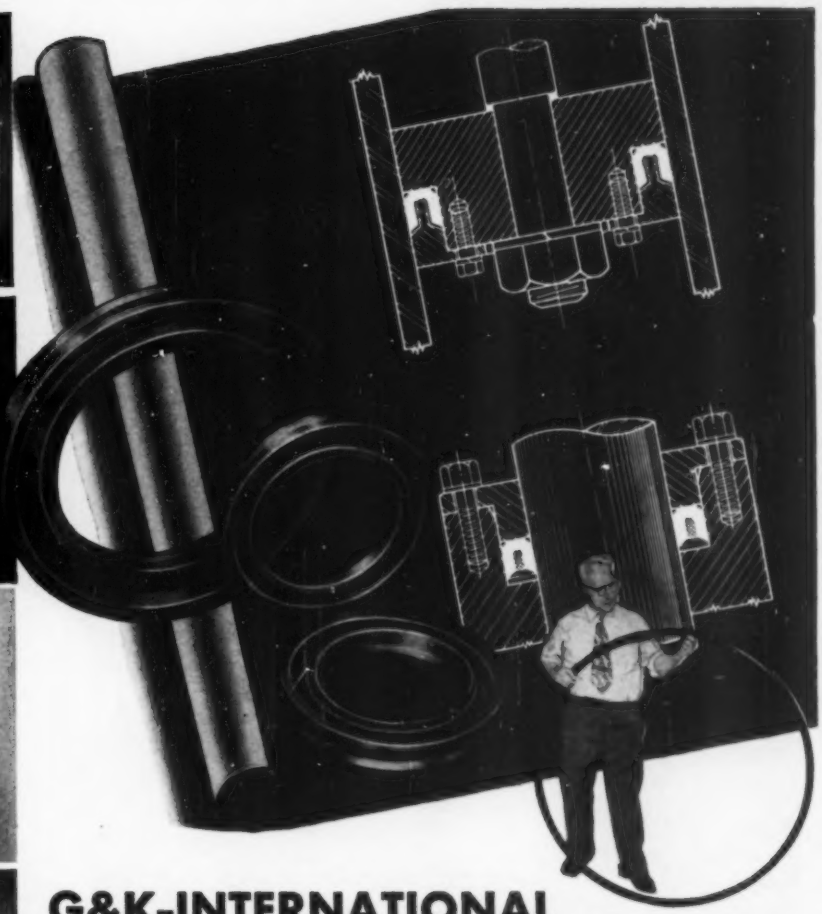
On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

U-PACKINGS

Made of leather or rubber. A completely mechanical seal installed in recess on cylinder wall or piston head. Sealing lips and side walls form dynamic seal inside and outside. Pedestal ring or filler required for best service. Expanders also adaptable when needed.







G&K-INTERNATIONAL can supply your packings needs—

standard or special — leather or rubber

With one entire plant specializing in packings design and manufacture, G&K - INTERNATIONAL offers a staff of technical experts with the latest in modern equipment and quality controls, backed by experience gained over 50 years in this field.

Whatever your packings requirements (Original Equipment or Replacement) you can bring them here with the assurance that you will get just the right packings. We work in both leather and rubber, and can fill orders on the basis of installation needs. For example, leather U packings are manufactured in sizes larger than those contained in the JIC tables — some as big as 6 feet in diameter!

To be sure that you get the *right* packings — *and on time* — *specify* G&K-INTERNATIONAL!

New Packings Catalog
Probably the most comprehensive catalog and manual in existence today. Covers all types, with latest tables. Also useful application information. Write for it — you ought to have a copy.

G&K INTERNATIONAL

GRATON AND KNIGHT

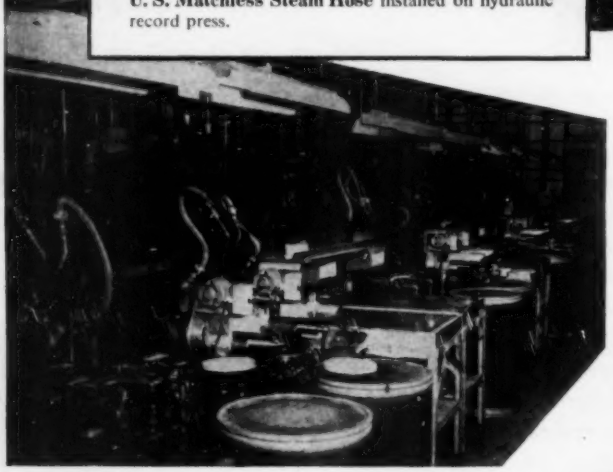
GRATON & KNIGHT COMPANY
Established 1851
Worcester 4, Massachusetts

INTERNATIONAL PACKINGS CORPORATION
Graton & Knight Company Affiliate
Bristol, New Hampshire

P-4

The U. S. Rubber hose that breaks records... and helps make 'em!

U. S. Matchless Steam Hose installed on hydraulic record press.



Battery of presses in the record factory. Note high flexibility of the hose.

Carrying steam at 350°F, 120 pounds pressure, and flexing 6 times a minute—that's the record-breaking job U. S. Matchless® Hose does in making phonograph records for an Eastern factory. Installed on hydraulic presses, Matchless has been on the job *for over two years* so far, with *no* failures. No ordinary hose could stand up under this treatment or protect the worker from dangerous steam. This United States Rubber Company hose really pays off in durability and safety.

Naturally, like every "U.S." product, Matchless Hose is the result of careful study and manufacturing control on the part of "U.S." engineers. For any industrial problem, call on these engineers at any of our 25 District Sales Offices. Or write to address below.

U.S.RUBBER
SERVING THROUGH SCIENCE

"U.S." Research perfects it.
"U.S." Production builds it.
U. S. Industry depends on it.

UNITED STATES RUBBER COMPANY

MECHANICAL GOODS DIVISION • ROCKEFELLER CENTER, NEW YORK 20, N. Y.

Hose • Belting • Expansion Joints • Rubber-to-metal Products • Oil Field Specialties • Plastic Pipe and Fittings • Grinding Wheels • Packings • Tapes Molded and Extruded Rubber and Plastic Products • Protective Linings and Coatings • Conductive Rubber • Adhesives • Roll Coverings • Mats and Matting

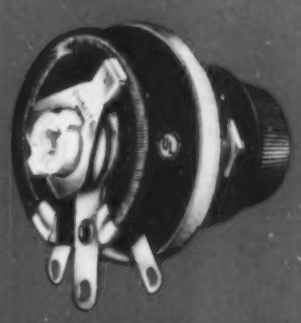
Röntgen
...First to discover the X-ray
Wilhelm Konrad Röntgen
1845-1923
Röntgen, a German physicist and educator, in 1895 discovered that a Crookes tube produced invisible rays that could penetrate opaque materials. He named these "X-rays." He also developed the basic methods of X-ray photography, and was awarded the Nobel Prize in 1901.

From an original drawing made for Ohmite

OHMITE®

...First in rheostats—today

You can *always* tell Ohmite rheostats by their unmatched smoothness of operation, dependability, and long, trouble-free life. Ohmite rheostats *perform* better because they're *built* better . . . designed with patented features that make them the most popular rheostat on the market . . . preferred by manufacturers everywhere. No wonder more Ohmite rheostats are sold than any other make!



Be Right with OHMITE

RHEOSTATS • RESISTORS • TAP SWITCHES

OHMITE®

FOR *Dependability*

RHEOSTATS

All-ceramic and metal, close control rheostats for unsurpassed dependability and smoothness of operation. Ten stock sizes, 25 to 1,000 watts.

TAP SWITCHES

Five compact models, 10 to 100 amperes, AC, up to 12 taps. All-ceramic and metal construction. Silver-to-silver contacts, with self-cleaning rotor.

RESISTORS

A wide range of dependable, fixed, adjustable, tapped, and non-inductive, power wire-wound resistors. Also a wide range of precision resistors.

R. F. CHOKES

Single layer R. F. plate chokes and power line chokes, on steatite or plastic cores. Protected by a special moisture-resistant coating.

Be Right with OHMITE

OHMITE MANUFACTURING COMPANY

4820 FLOURNOY STREET, CHICAGO 44, ILLINOIS

WRITE on company letterhead for Catalog and Engineering Manual No. 40

lower
NEW PRICES
BOSTON Gear
SAME QUALITY

Look in the Yellow Classified Telephone Directory under "Gears" for the authorized BOSTON Gear DISTRIBUTOR nearest you.

Get this NEW BOSTON Gear
SPROCKET CATALOG
SUPPLEMENT SC-2

Every sprocket user will want this new, up-to-the-minute 48-page book of buying information on . . .

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New LOWER prices, based on larger volume, and on engineering and production economies, mean substantial savings for all sprocket buyers, whether typical order is large or small.

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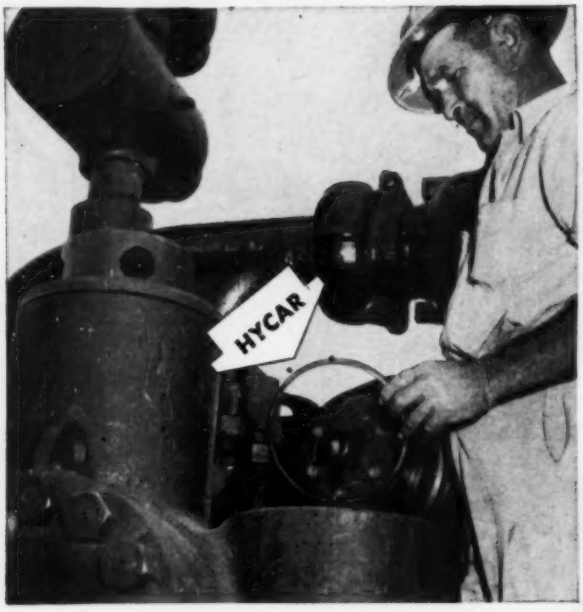
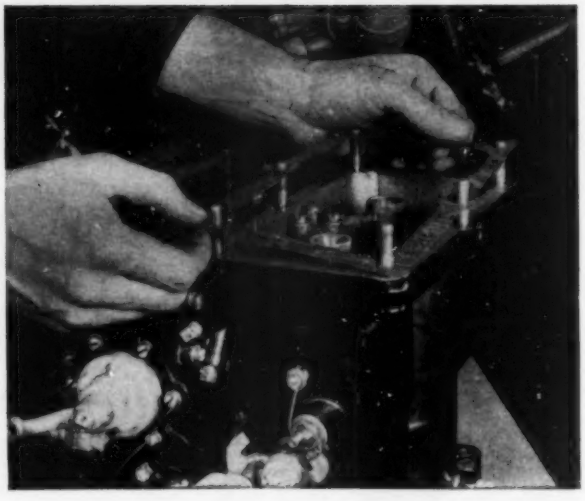
BOSTON Gear
DISTRIBUTOR

for the new Sprocket Catalog Supplement SC-2 or write: Boston Gear Works, 60 Hayward St., Quincy 71, Mass.

More developments using

B. F. Goodrich Chemical *raw materials*





B. F. Goodrich Chemical Company does not make these products. We supply the Hycar rubber only.

On Aircraft, Oil Well and Electrical Jobs

. . . versatile Hycar scores high!

LOOK at the three typical uses of Hycar pictured. They show the wide range of applications for this versatile American rubber. And they also show how Hycar helps improve products and operations —save money.

The carburetor gasket is used on a Navy helicopter. Hycar bonds the asbestos fibers of the gasket, helps seal power *in*—keep trouble *out*. Hycar resists heat, oil, solvents and retains its high tensile strength. It helps make the gasket non-absorbing, non-swelling and non-cracking.

The Hycar rubber "O" ring seal is one of many uses for Hycar in the petroleum industry. It's used on a powerful pump designed for jet bit, big hole and deep drilling. The Hycar "O" ring seals tightly, resists abrasion and the hydrocarbons entrained in the drilling fluid.

On the volt-ammeter, the trigger is made with a Hycar rubber-phenolic compound. Breakage under sudden pressure which used to plague rag-filled phenolic triggers has been reduced almost to zero.

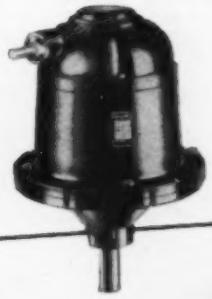
Hycar's many advantages may be the perfect answer to your product improvement or development problems—and your sales plans. We'll help you select a Hycar rubber compound exactly suited to your needs. For technical information, please write Dept. HT-4, B. F. Goodrich Chemical Company, Rose Building, Cleveland 15, Ohio. Cable address: Goodchemco. In Canada: Kitchener, Ontario.

B. F. Goodrich Chemical Company
A Division of The B. F. Goodrich Company

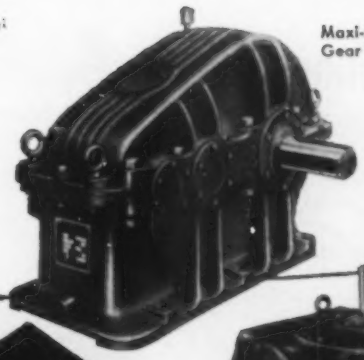
Hycar
American Rubber

GEON polyvinyl materials • HYCAR American rubber • GOOD-RITE chemicals and plasticizers • HARMON colors

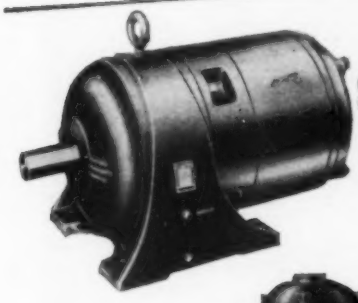
Line-O-Power
Straight Line Drive
(Foot Mounted)



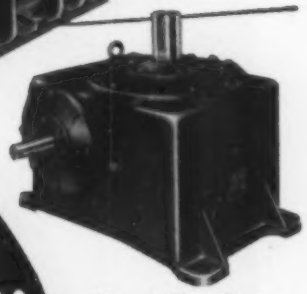
Line-O-Power Right Angle
Drive (Flange Mounted)



Maxi-Power Helical
Gear Drive



Foote Bros.-Louis Allis
Horizontal Gearmotor



Hygrade Worm Gear
Vertical Drive

name your job...

FOOTE BROS. DRIVES WILL HANDLE IT!

Foote Bros.-Louis Allis
Vertical Gearmotor

Hygrade Worm Gear
Horizontal Drive

Worm-Helical Gear
Drive

At Foote Bros. you will find a complete line of enclosed helical and worm gear drives for every job. Ratios and capacities to answer every speed reduction need. Also available to assure long and satisfactory service is a complete line of Foote Bros.-Louis Allis Gearmotors, both vertical and horizontal.

Foote Bros. offers these advantages: Nearly 100 years of design, engineering and manufacturing experience—the latest in gear-cutting techniques—better control of materials. Modern production techniques at three large plants assure superior drives for every power transmission requirement.

Mail coupon for information.

FOOTE BROS.

Better Power Transmission Through Better Gears

FOOTE BROS. GEAR AND MACHINE CORPORATION
4545 South Western Boulevard, Chicago 9, Illinois

Foote Bros. Gear and Machine Corporation
Dept. W, 4545 South Western Boulevard
Chicago 9, Illinois

Please send me information on the following:

☐ Line-O-Power Drives ☐ Maxi-Power Drives
☐ Hygrade Drives ☐ Worm-Helical Gear Drives
☐ Foote Bros.-Louis Allis Gearmotors

Name.....

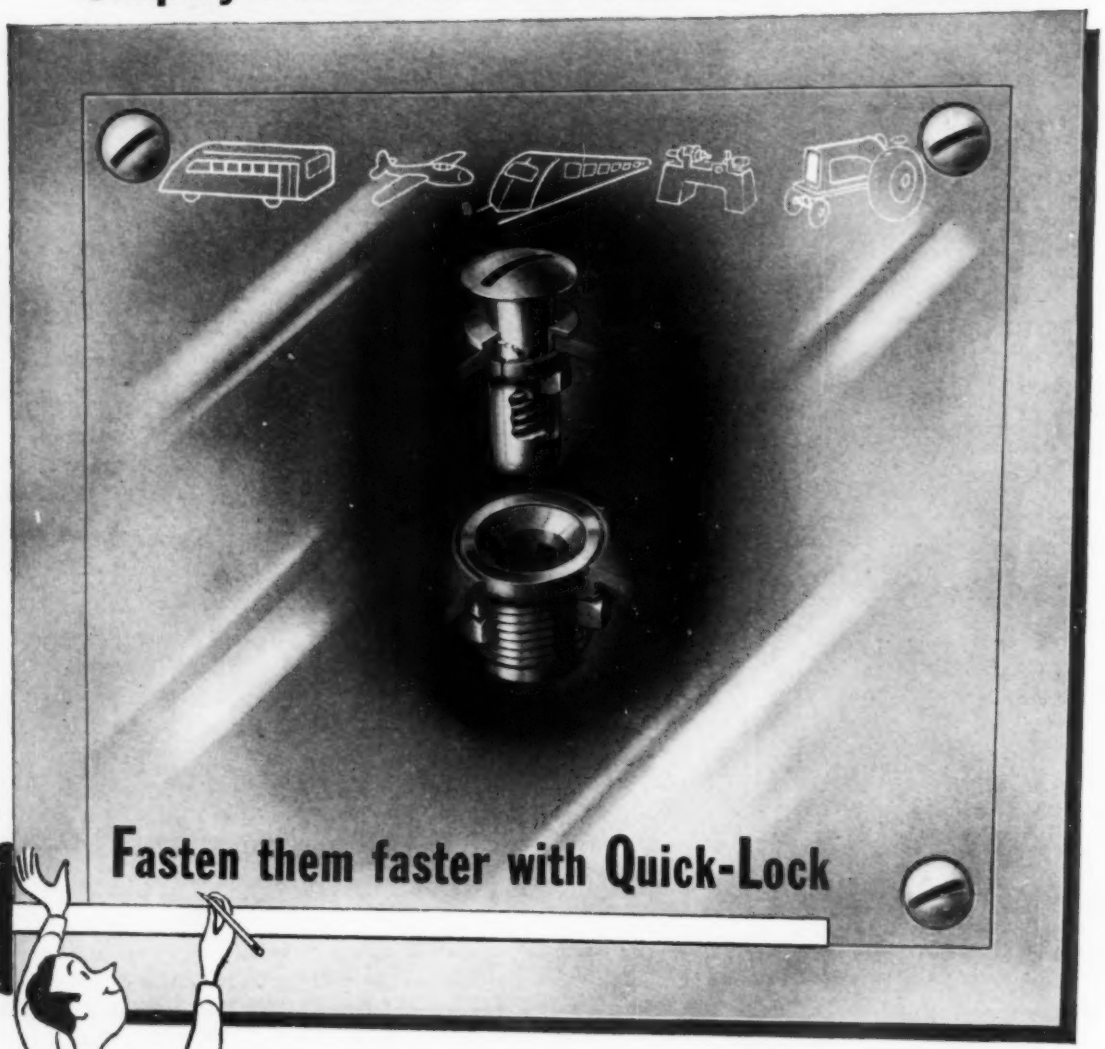
Company.....

Address.....

Position.....

City.....*Zone*.....*State*.....

Simplify Your Access Panel and Door Assemblies...



Fastening removable access doors and panels need not be a laborious and costly production or assembly operation—not if they're fastened with QUICK-LOCK.

Designed for simple installation, QUICK-LOCK requires no special tools. It speeds up mounting and demounting detachable panels with only a 90° turn required to lock and unlock it *in a jiffy*.

The flexible mounting and tapered stud makes QUICK-LOCK ideal for assembling curved sheets and insures a tight fit when locked. Stud is self-ejecting when unlocked. Minimum deflection is assured—only initial loads are carried by the helical spring. Solid supports take up increased loads.

Industrial and agricultural equipment manufacturers would do well to analyze the cost-saving features of QUICK-LOCK's simple design. A good way would be to call in a Simmons Engineer and discuss the economy of a QUICK-LOCK installation as compared to your present fastening method. Why not send for him today?

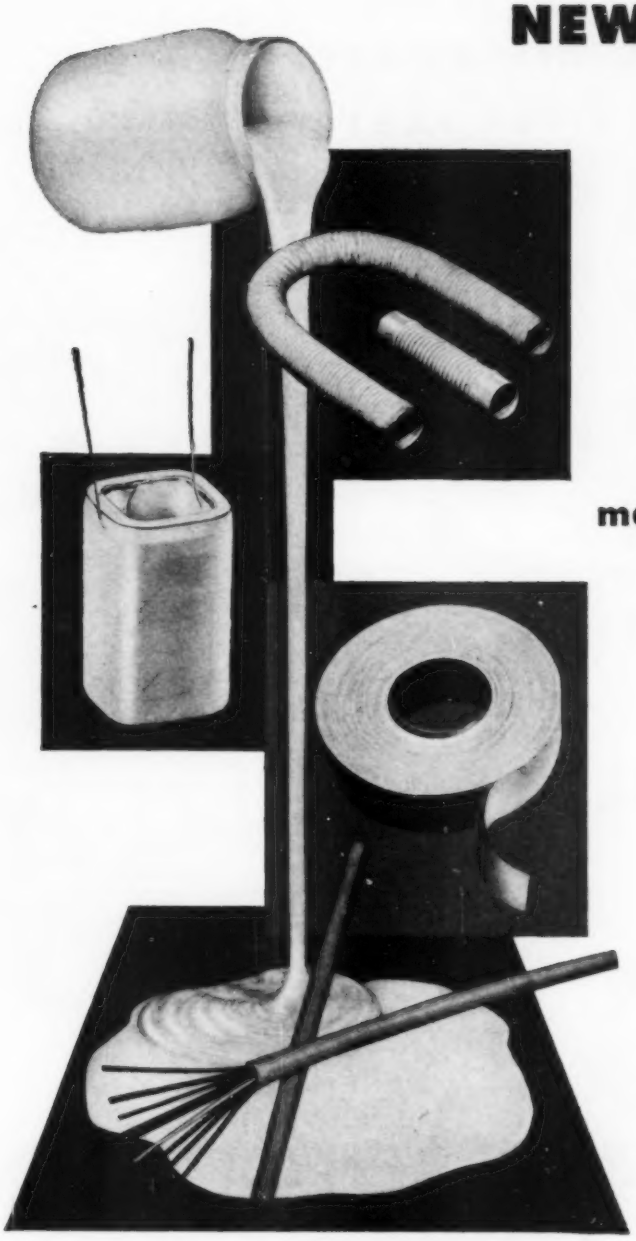
SIMMONS FASTENERS

SIMMONS FASTENER CORPORATION • 1751 NORTH BROADWAY, ALBANY 1, N. Y.

NEW

SILICONE RUBBER COMPOUND

for electrical and mechanical applications



SE-100 COMBINES

- **Outstanding heat resistance**
- **Outstanding electrical properties**
- **Outstanding physical properties**
- **Ease of application**

You can now extend equipment life and minimize insulation failures by specifying General Electric's new silicone rubber compound, SE-100.

SE-100 may be coated on glass or organic fabrics for service at high or low temperatures or where resistance to weather, ozone, corona or chemicals is required. In addition, SE-100 is available as a dispersion (SE-100S) and may be used to encapsulate coils and components for electrical insulating purposes.

SUGGESTED USES

Electrical: Cloth, tape and sleeving; coating for glass-served wire; encapsulating coatings.

Mechanical: Ducts and tubing; gaskets and seals; diaphragms.

HERE'S PROOF!

Typical properties of glass cloth coated with SE-100:

Dielectric strength, volts/mil	1200-1400
Power factor, 60 cycles	
85 F	0.0110
212 F	0.0072
Tensile strength, lbs./in. width	150
% Moisture absorption, 96 hrs.	0.11
Serviceable from	−76 to 480 F

G-E silicones fit in your future

GENERAL ELECTRIC

CLIP AND MAIL TODAY!

General Electric Company
Section 353-5B
Waterford, New York

Please send me product data on SE-100, list of fabricators, and a free copy of *G-E Silicones for Industry*.

Name_____ Position_____

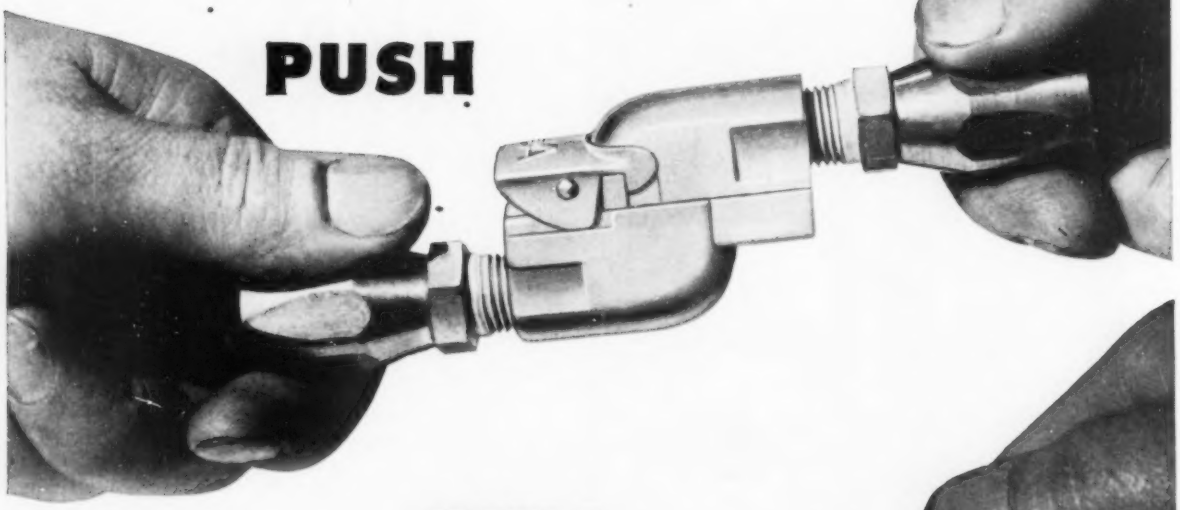
Firm_____

Street_____

City_____ Zone____ State_____

(In Canada, mail to Canadian General Electric Company, Ltd., Toronto.)

TO CONNECT AND DISCONNECT FLUID-CARRYING LINES *FAST*



Aeroquip
REG. TRADE MARK

SLIDE-SEAL COUPLINGS

This Aeroquip development saves you time and money!

LOW COST . . . Aeroquip Slide-Seal Couplings connect and disconnect fluid-carrying lines instantly assuring full flow of fluids when connected, and perfect seal of each half when disconnected.

LIGHTWEIGHT AND COMPACT . . . They are ideal for use in confined areas and may be used to advantage in a wide variety of applications.

SIMPLE DESIGN . . . Only four working parts and two "O" rings assure positive performance and foolproof operation.

ADAPTABLE for use with many fluids including hydraulic fluids, hot oil, crude and fuel oils, anti-freeze solutions, gasoline, Diesel fuels, air, water, and other fluids.

Descriptive literature is available . . . please write.

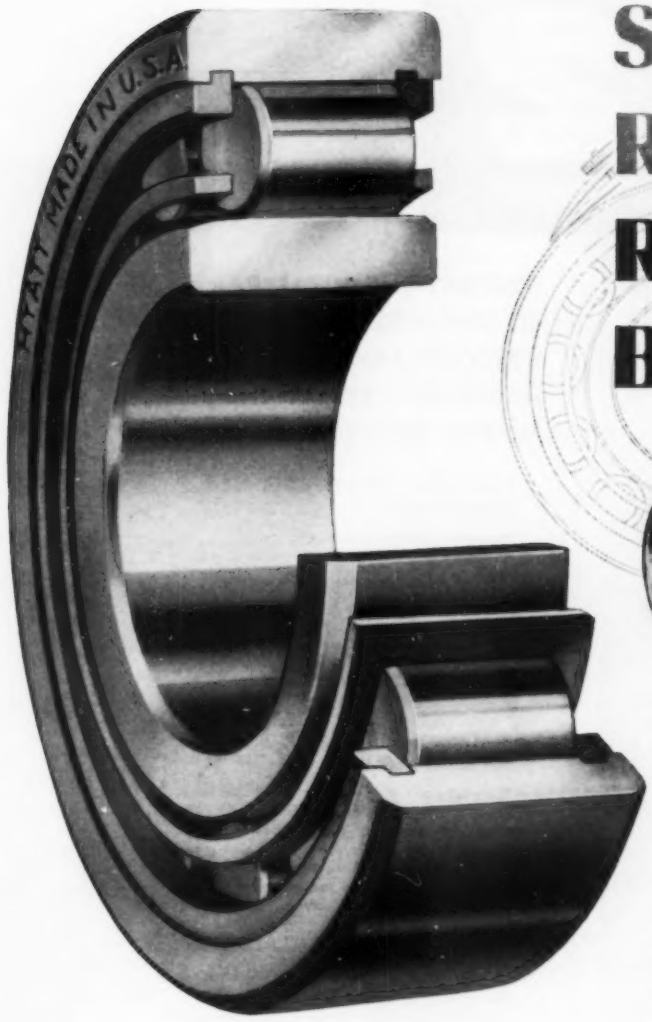
AEROQUIP CORPORATION, JACKSON, MICHIGAN

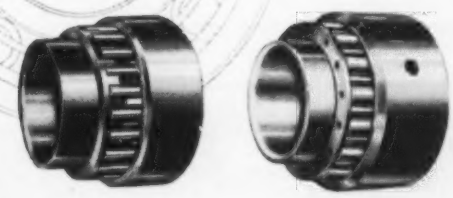
SALES OFFICES: BURBANK, CALIF. • DAYTON, OHIO • HAGERSTOWN, MD. • HIGH POINT, N. C. • MIAMI SPRINGS, FLA. MINNEAPOLIS, MINN. • PORTLAND, ORE. • WICHITA, KAN. • TORONTO, CANADA

AEROQUIP PRODUCTS ARE FULLY PROTECTED BY PATENTS IN U.S.A. AND ABROAD

Answer to a LOADed question . . . the best way to handle radial loads is with . . .

HYATT STRAIGHT RADIAL ROLLER BEARINGS





Wherever the jobs . . . and the loads . . . are big, you'll find radial roller bearings smoothing the path of power, because radial roller bearings give the greatest load-carrying capacity within given boundary dimensions. And, whenever radial loads enter the picture, design engineers naturally turn to Hyatt for the most complete line of radial roller bearings available anywhere. The wide range of Hyatt Roller Bearing sizes and types allows the engineer greater design flexibility, makes his job easier. If you are not familiar with the complete Hyatt line, write for our general catalog No. 150. Hyatt Bearings Division, General Motors Corporation, Harrison, N. J.

HYATT ROLLER BEARINGS

STEP 1

ENGINEER THE PERFORMANCE OF YOUR a Century application engineer will from this wide range of

FOR TOP PERFORMANCE SELECT THE ELECTRICAL CHARACTERISTICS TO MATCH THE LOAD FUNCTIONS OF YOUR EQUIPMENT

- ☐ SINGLE PHASE OR POLYPHASE A.C. OR D.C.
- ☐ SELECTION OF RATING FROM WIDE RANGE —⅛ to 400 H.P.
- ☐ SELECTION OF PROPER LOADING FACTOR FOR SAFE TEMPERATURES AND EFFICIENT OPERATION:
  - ☐ Continuous general purpose rating.
  - ☐ Short time special rating.
  - ☐ With consideration to ambient temperatures for either of these.

SELECTION OF VARIOUS TORQUE CHARACTERISTICS FOR:

- ☐ Starting torque required which varies with class of equipment.
- ☐ Accelerating torque required which varies with inertia—friction—compression of the load.
- ☐ Maximum torque required which may vary with momentary overloads.

SELECTION OF TORQUE CHARACTERISTICS AND RATING FOR REVERSING ROTATION OF LOAD:

- ☐ Where motor comes to full stop before reversing.
- ☐ For instantaneous reversing (plugging) with reference to load inertia or other load factors.

SELECTION OF RATING FOR "START" AND "STOP" CYCLE FOR:

- ☐ Standard ratings for infrequent starts and stops.
- ☐ Special rating depending on frequency of starts and stops.

SPEED REGULATION AND CONTROL FOR:

- ☐ Select normal slip for good constant speed regulation.
- ☐ Select high slip, to absorb shock of impact loads.
- ☐ Select adjustable varying speed for uniformly constant load.
- ☐ For speed adjustment in fine steps, variable load, use adjustable voltage control.
- ☐ For speed adjustment in wide fixed steps, use multi-speed motors furnished for:
  - ☐ Constant H.P.
  - ☐ Constant torque
  - ☐ Variable torque

SELECT MOTOR WITH:

- ☐ Normal starting current for power circuits with good voltage regulation.
- ☐ Lowest starting current for power circuits where voltage fluctuates widely (R.E.A. lines).

STEP 2

PROTECT THE VITAL PARTS OF THE MOTOR FROM VARIOUS ATMOSPHERIC HAZARDS — SELECT THE MOTOR FRAME PROTECTION

☐ **DRIP PROOF—OPEN TYPE GENERAL PURPOSE FRAME**

For normal atmospheric conditions.

☐ **SPLASH PROOF—OPEN TYPE FRAMES**

Can be used out of doors without further protection or in plants where equipment must be washed down with a hose. For plants like dairies or other processing plants. Or for cooling towers, oil field pumping units, etc., out of doors.

☐ **DUST PROOF—TOTALLY ENCLOSED FAN COOLED FRAME**

The vital parts of the motor are sealed in. Used where the atmosphere is charged with abnormal amounts of dust, grit, oil fog, etc. This frame has high acceptance in high speed mass production metalworking plants or wherever a highly charged atmosphere would affect the life of the motor.

☐ **EXPLOSION PROOF—TOTALLY ENCLOSED FAN COOLED FRAME**

The frame is sealed in, in a manner which prevents a spark inside the frame from igniting combustible materials or gases outside the frame. The motors have an "Underwriters' Label" indicating the design has been approved by the Underwriters' Laboratories for certain specified classes of explosives.

☐ **TEXTILE—OPEN TYPE FRAME**

This motor is designed with wide open air passages, with smooth surfaces. It actually sheds lint, with which the air is highly charged in textile plants.

CALL A Century APPLICATION ENGINEER ...from a Century Branch Office, located in principal cities in U. S.

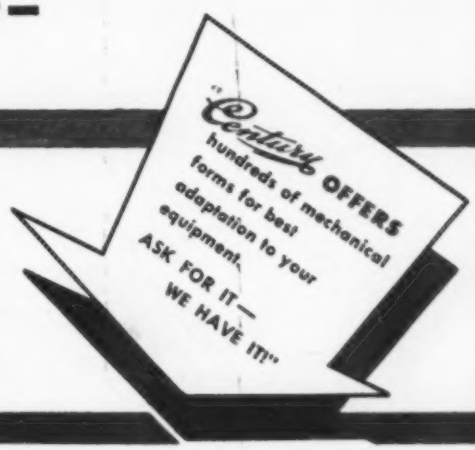
CENTURY ELECTRIC

PRODUCTS THROUGH SKILLFUL MOTOR APPLICATION

help you select the right motor— Century motor specifications

For more than 50 years,

Century motors have been satisfying the requirements of equipment manufacturers — often with the most exacting specifications. This has produced a great teamwork between Century engineers and the customers' engineering department.



STEP 3

FOR IDEAL ADAPTATION OF THE MOTOR TO YOUR EQUIPMENT—

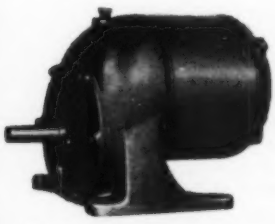
Here are a few samples of the many mechanical forms to select from

☐ Hermatically sealed refrigeration motor

☐ Oil burner motor

☐ Textile motor

☐ Vertical fan motor



☐ Parallel shaft gear motor

☐ 20 kw generator

☐ Vertical ball-bearing flange mounted motor

☐ Vertical motor with brake attachment

Ask about a sample

Century motor, scientifically selected, for actual test performance on your equipment.

Ask about Century's National Network of Authorized Motor Service Stations to solve your motor service problems in the field.

☐ Pedestal mounted gear motor

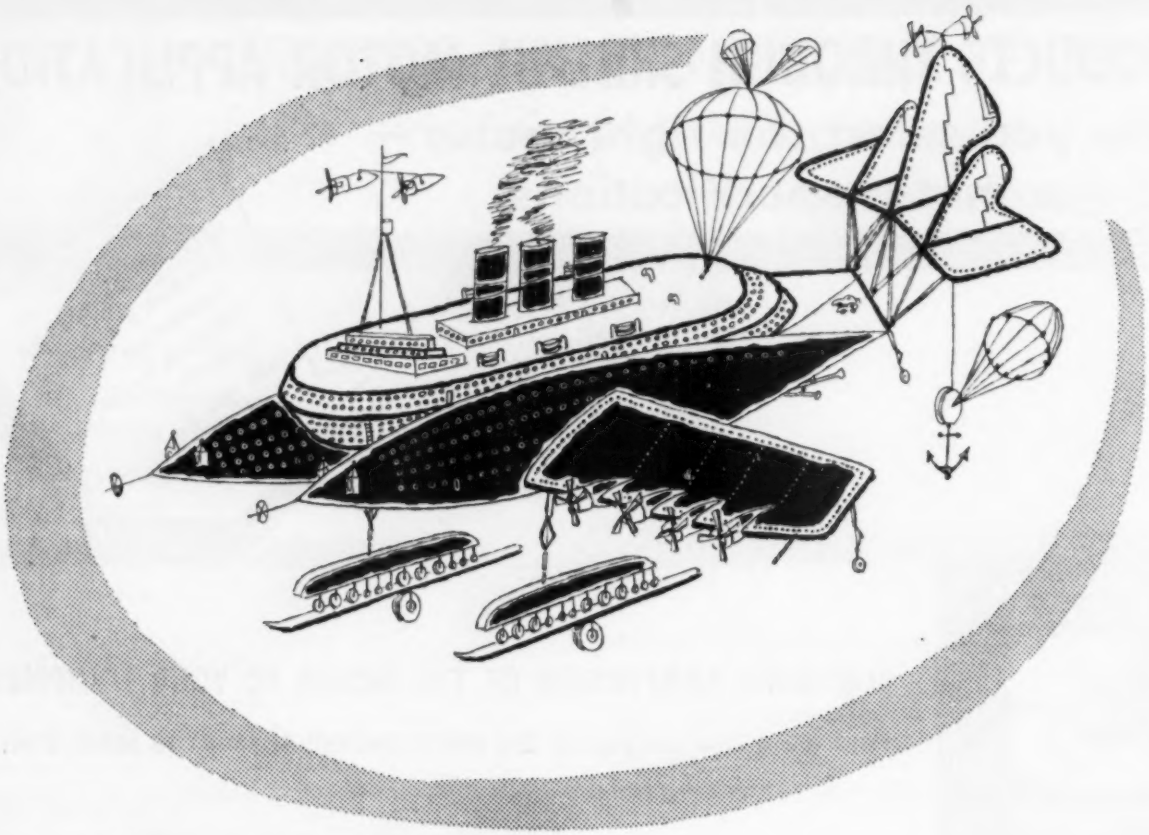
☐ Fractional capacitor motor

☐ Totally enclosed DC marine motor

C O M P A N Y

1806 PINE STREET • ST. LOUIS 3, MO.
Offices and Stock Points in Principal Cities

Century Electric MOTORS



too many cooks...

No, this isn't an original daVinci, it's just our way of showing you what can happen when too many people are on the same job . . . and what can happen (in effect) when you buy stainless steel tubing from one source, and have it fabricated to your specification at another.

Q *question*
Why do Bishop "pre-fabricated" specialties save money? (answer: Less cooks . . . all operations from redraw to finished parts are done under one roof.)

Q *question*
How much does transportation cost when a redraw mill *and* a fabricator do your work? (answer: Up to twice as much.)

Q *question*
How much time do Bishop "pre-fabricated" specialties save? (answer: Considerable, because of less handling, less freight and less set-up time.)

Here's how to speed up delivery of fabricated tubular specialties, assure lower per unit cost, and positively eliminate the possibility of ordering the wrong type tubing for the specialty to be fabricated . . . buy tubular specialties fabricated at the redraw mill.

Bishop, the only redraw mill that specializes in specialties, saves you time and money, lowers handling costs, reduces transportation charges. Why? Because there are less "cooks" . . . fewer hands to handle your product because everything is done under one plant roof.

Whether you require stainless steel tubing, or tubular specialties, Bishop's 110 years precision manufacturing experience and 25 years handling stainless steel, are your assurance of quality craftsmanship.

THE ONLY REDRAW MILL THAT SPECIALIZES IN SPECIALTIES

J. BISHOP & CO. • Platinum Works

Stainless Steel Division

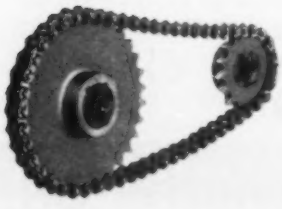
Malvern Pennsylvania

Link-Belt roller chain sprockets with taper lock bushings

HERE'S great news for users of roller chain drives! With the new Link-Belt taper lock sprocket, you don't have to fit the sprocket to the shaft. These sprockets with their taper lock bushings give you the equivalent of a shrink-fit on all standard shaft sizes.

Installation and removal are fast, simple. Set screws force and hold bushing in tapered bore of sprocket, *clamp* it tightly onto shaft. The *full length* of the bushing supports the sprocket on the shaft. Turning set screws in removal holes quickly releases it from shaft.

What's more, it's no longer necessary to wait while wheels are rebored. You can pick these sprockets right off the shelf at your nearby Link-Belt distributor or factory branch store. Available now are sizes for ½, ⅜, ¾, 1 and 1¼-in., single-width chains with other sizes to be announced. Ask for Bulletin 2449.



AN IDEAL COMBINATION:
LINK-BELT PRECISION STEEL ROLLER CHAIN & LINK-BELT SPROCKETS

LINK-BELT

ROLLER CHAIN AND SPROCKETS

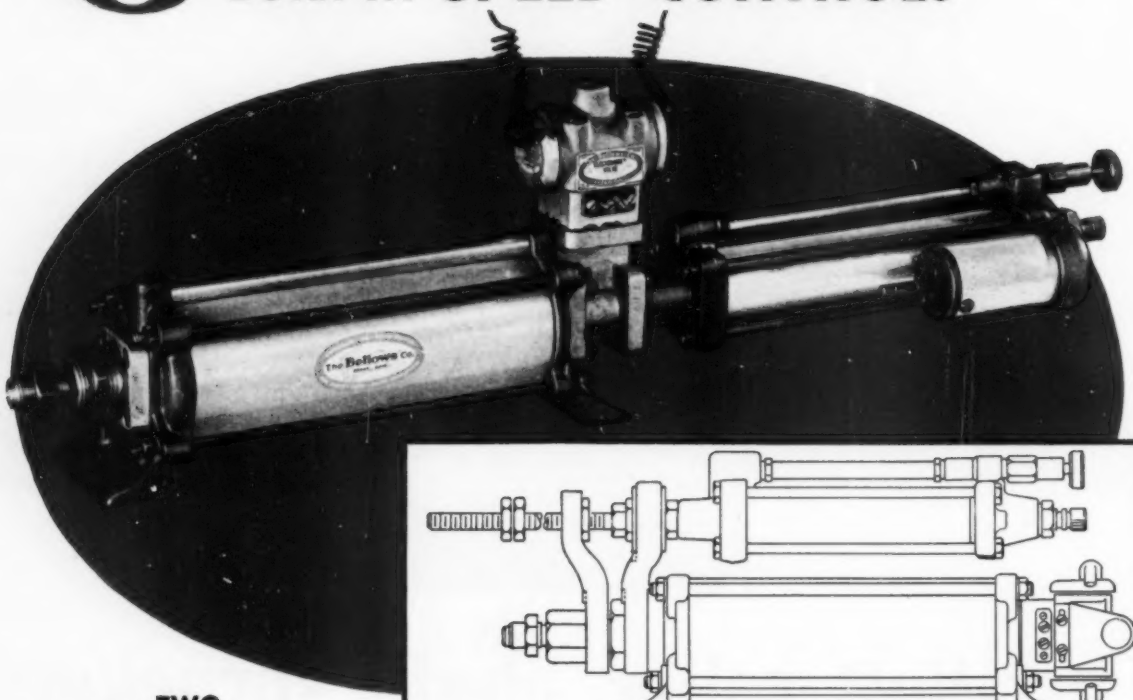
LINK-BELT COMPANY: Plants: Chicago, Indianapolis, Philadelphia, Colmar, Pa., Atlanta, Houston, Minneapolis, San Francisco, Los Angeles, Seattle; Scarboro, Toronto and Elmira, Ont. (Canada); Springs (South Africa); Sydney (Australia). Sales Offices, Factory Branch Stores and Distributors in Principal Cities. 13 201

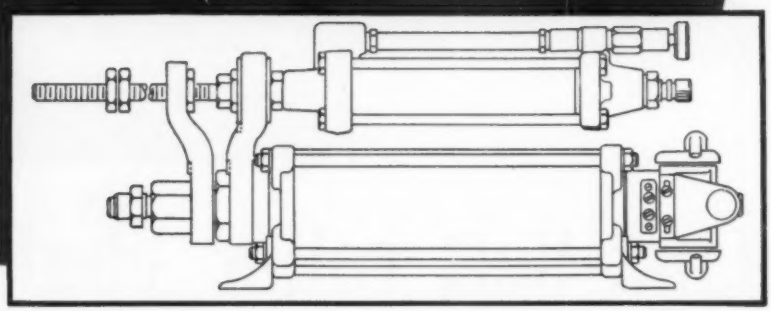
This Air Cylinder Combines

1 BUILT-IN **HYDRAULIC CONTROL**

2 BUILT-IN **ELECTRIC CONTROL**

3 BUILT-IN **SPEED CONTROLS**





TWO MOUNTING STYLES

The Bellows Air Motor and Hydro-Check (Model HCB-EM) is available arranged in tandem as shown above, or in parallel, as sketched.

●

Combination units of Air Motor and Hydro-Check are also made with any one of six other Bellows directional valve arrangements; and, of course, Air Motors and Hydro-Checks are available as separate units.

In one compact packaged power unit are built-in controls to cover every phase of air cylinder operation. Built-in hydraulic control of piston rod movement gives the characteristic smoothness of hydraulic operation, yet retains the speed and flexibility of air power. Built-in electrically controlled directional valve permits quick, positive, remote control, or easy electrical synchronization with other machine elements. Built-in speed controls permit exact control of piston rod speed in either or both directions.

This combination of Bellows Air Motor and Hydro-Check is available in five bore sizes: 1¼", 1¾", 2½", 3⅝" and 4½" in standard stroke lengths up to 18".

Here is air cylinder power at its best — fast, flexible, safe, and smooth.

BULLETIN CL-50 TELLS THE STORY. WRITE FOR IT TODAY!

DEPT. PE 753

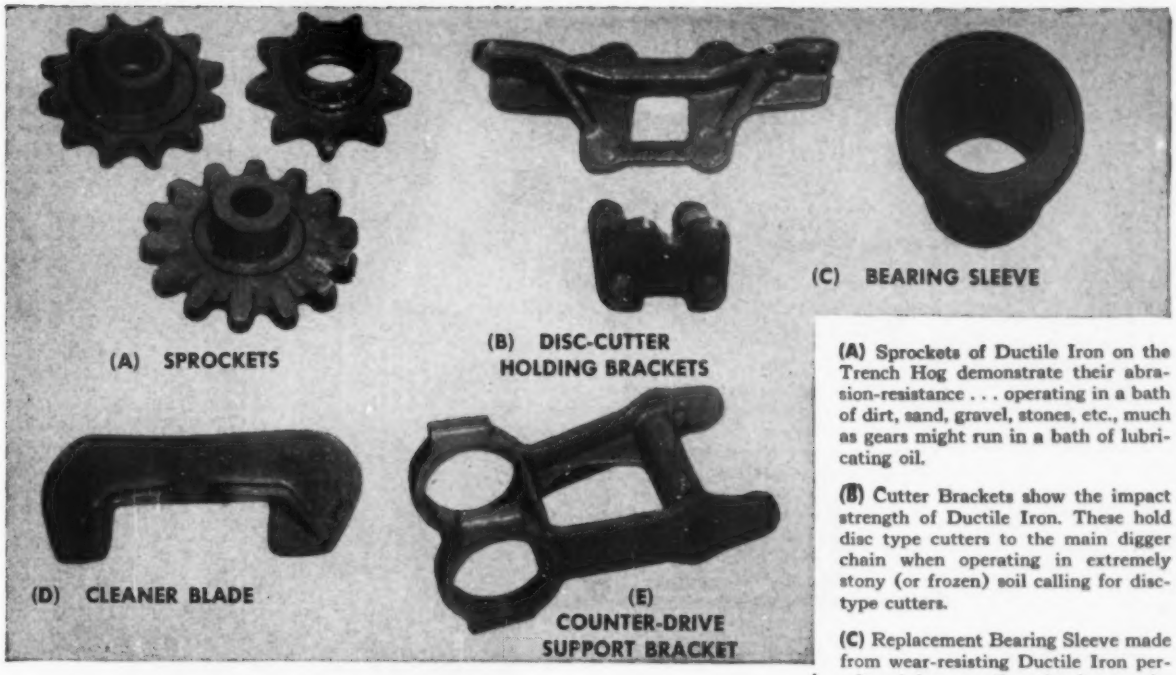
Controlled-Air-Power

The Bellows Co.

AKRON 9, OHIO

699-A

FOR FASTER, SAFER, BETTER PRODUCTION



(A) Sprockets of Ductile Iron on the Trench Hog demonstrate their abrasion-resistance . . . operating in a bath of dirt, sand, gravel, stones, etc., much as gears might run in a bath of lubricating oil.

(B) Cutter Brackets show the impact strength of Ductile Iron. These hold disc type cutters to the main digger chain when operating in extremely stony (or frozen) soil calling for disc-type cutters.

(C) Replacement Bearing Sleeve made from wear-resisting Ductile Iron permits minimum wall section because its strength is much higher than that of gray iron, although it has the same machinability rating.

(D) Cleaner Blades of Ductile Iron mounted at regular intervals on the digger chain withstand battering and abrasion by stones and soil. These parts also prove the impact resistance of Ductile Iron.

(E) Counter-drive Support Brackets are subject to twisting action. Ductile Iron makes possible smaller, lighter brackets . . . with a higher safety factor against breakage.

Test DUCTILE IRON on Your Tough Jobs for a "SHOWDOWN" PROOF of its

- **Resistance to Wear**
- **Resistance to Impact**
- **High Strength**
- **Superior Machinability**

Only actual use can demonstrate the remarkable properties of Ductile Iron.

For Ductile Iron combines the *process advantages* of cast iron . . . such as good castability, ready machinability and moderate cost . . . with many of the *product advantages* of steel.

Several times stronger than ordinary cast iron, Ductile Iron also offers greatly increased shock resistance and ductility. As an example of some of Ductile Iron's many useful applications, look at the parts produced by STATE FOUNDRY AND MACHINE COMPANY, Cedar Grove, Wisconsin, for use on the Trench Hog digger manufactured by ARPS CORPORATION, New Holstein, Wisconsin.

Send us details of your prospective uses, so that we may offer a list of sources from some 100 authorized foundries now producing Ductile Iron under patent licenses. Request a list of available publications on Ductile Iron . . . mail the coupon now.

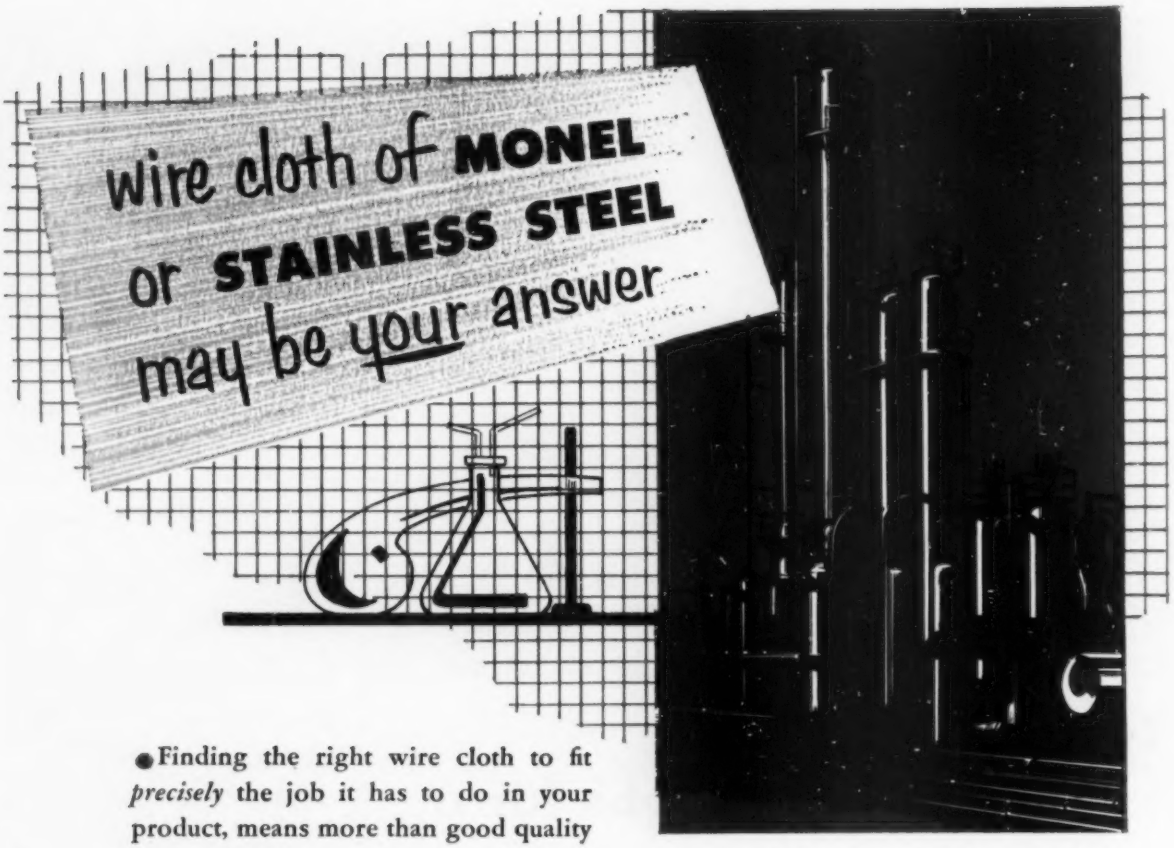
The International Nickel Company, Inc.
Dept. 20, 67 Wall Street, New York 5, N. Y.

Please send me a
list of publications on Ductile Iron

Name_____ Title_____
Company_____
Address_____
City_____ State_____

THE INTERNATIONAL NICKEL COMPANY, INC. 67 WALL STREET NEW YORK 5, N. Y

wire cloth of MONEL or STAINLESS STEEL may be your answer



●Finding the right wire cloth to fit *precisely* the job it has to do in your product, means more than good quality and uniformity . . . more than the right type and size of wire, or mesh, or type of weave. It has to be right metallurgically and chemically . . . to prevent failures . . . to improve your product performance.

Reynolds stainless steel, or Monel metal cloth has a remarkable range of properties, in addition to resisting chemical and atmospheric corrosion. Stainless steel resists oxidation, and oxidizing solutions. It resists many acids; acid and alkaline salts; acetone, ethyl alcohol, benzene, chloroform, etc.

Stainless steel wire cloth as Reynolds makes it, is shock-resistant and non-magnetic, with good weldability . . . is strong enough to defy high temperatures and resist scaling; tough enough to take sub-zero temperatures to minus 320° F. *Consult Reynolds engineers.* No cost or obligation.

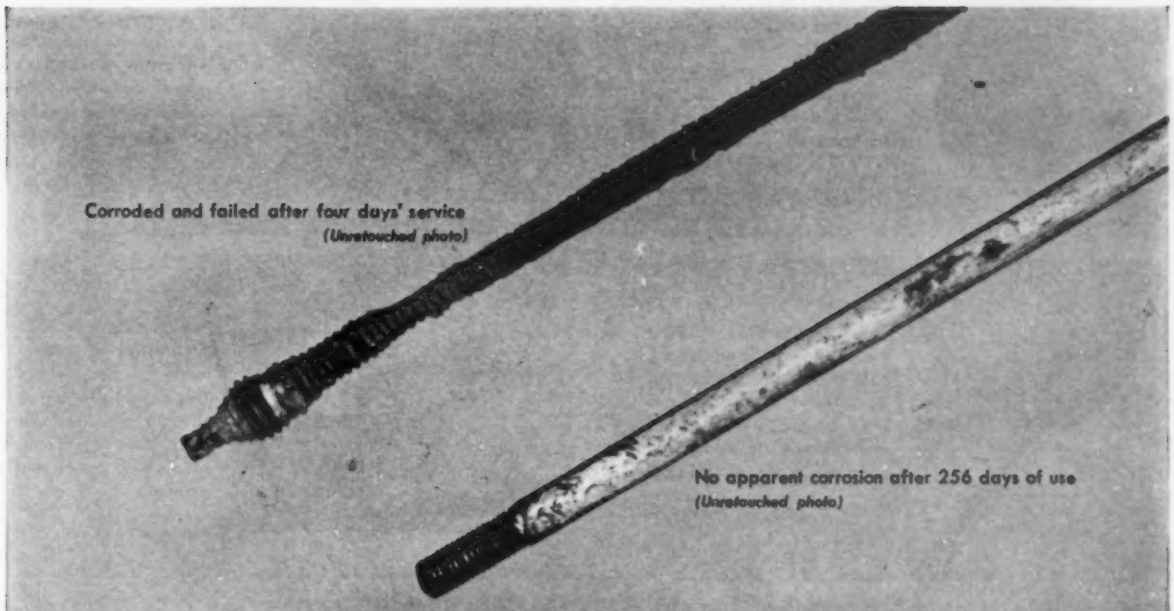
REYNOLDS WIRE CLOTH

REYNOLDS WIRE DIVISION, NATIONAL-STANDARD CO., **DIXON, ILLINOIS**

NS NATIONAL-STANDARD Company NILES, MICHIGAN

Divisions of National-Standard Co.

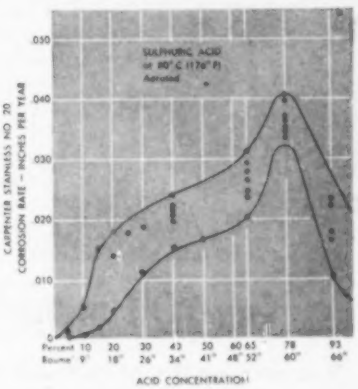
ATHENIA STEEL...*Clifton, N. J.*.....Flat, High Carbon, Cold Rolled Spring Steel
NATIONAL-STANDARD...*Niles, Mich.*.....Tire Wire, Fabricated Braids and Tape
WAGNER LITHO MACHINERY...*Jersey City, N. J.*.....Metal Decorating Equipment
WORCESTER WIRE WORKS...*Worcester, Mass.*....Round and Shaped Steel Wire, Small Sizes


Corroded and failed after four days' service
(Unretouched photo)
No apparent corrosion after 256 days of use
(Unretouched photo)

Is the Handling of Corrosive Acids, such as Sulphuric, Causing Headaches in Your Plant?

Today many plants are enjoying new freedom from corrosion, longer equipment life and fewer shutdowns . . . because of Carpenter Stainless No. 20. Take the job shown above. In this application, ½" rd. rods of Carpenter No. 20 and Stainless Type 316 were installed to handle H_2SO_4 at the rate of about 50 gallons a minute in a full range of solution varying from 0% up to 58% concentration. Temperature: 70° C. (158°F.). After four days the Type 316 rods failed and were replaced with ½" sq. No. 20 rods. After being in service 3,747 hours of a possible 6,144 hours over a period of 256 days, the No. 20 rods showed no apparent corrosion whatsoever. (See unretouched photo above.) Of course, Type 316 is satisfactory for certain dilute solutions of H_2SO_4 and many other corrosive conditions. But with a tough problem like the one described here, it takes No. 20 to do the job.

While the production of Stainless No. 20 is controlled by Government Regulations, you may be able to obtain Government approval of its use, depending on the nature of your job. If not, keep these facts in mind because of their importance in your planning for future products. Meantime, write on your Company letterhead for more details in the No. 20 booklet. Also, get in touch with us for No. 20 test coupons. We'll be glad to work with you. The Carpenter Steel Company, 117 W. Bern St., Reading, Pa.

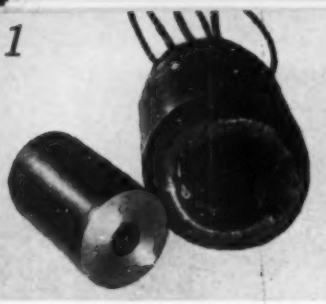


Carpenter STEEL — **Stainless No. 20**

Export Department: The Carpenter Steel Co., Port Washington, N.Y.—"CARSTEELCO"

Mill-Branch Warehouses and Distributors in Principal Cities Throughout the U.S.A. and Canada

1



R & M Polyphase motor parts, consisting of rotor and stator, horizontal position. Light weight and reserve power for heavy duty use were the most important motor characteristics required.

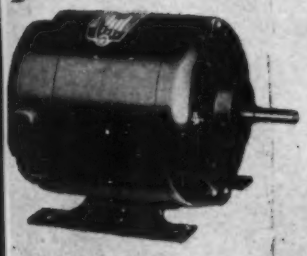
2

This motor had to be lightweight, powerful and capable of running for long periods at 36,000 R.P.M. It's dynamically balanced with a diamond-turned commutator and specially anchored windings.

3

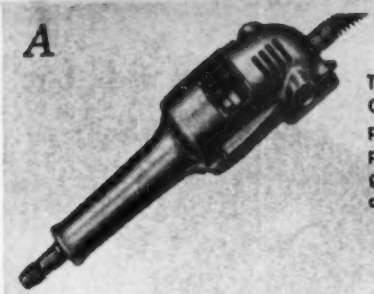
This powerful R & M Motor has a high starting torque for quick response; it runs cooler than normal, it's exceptionally quiet, and it's *compact*. Extra-heavily insulated, dynamically balanced, 100% inspected.

4



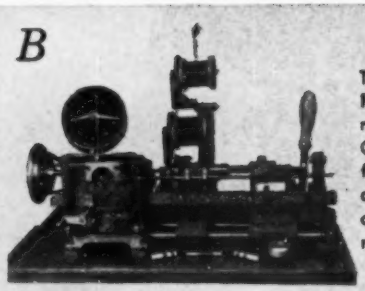
Variable speed was a must for this R & M Motor—to permit a wide selection of speeds without need for changing belts or pulleys. Motor is ¼ HP, AC-DC 5000 R.P.M., ball bearing equipped and open ventilated.

A



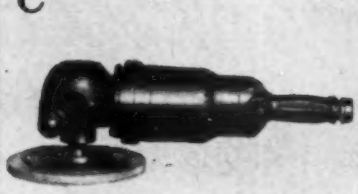
The ultra-high-speed SKIL Grinder, made by Skil Corporation, packs twice the power per pound of other grinders of similar weight. Tool and die makers say it's great!

B



The Geo. Stevens Model 125 Progressive Universal Winder made by Geo. Stevens Mfg. Co., Inc., world's largest manufacturer of coil-winding machines. One of a complete line of R & M Motor-equipped machines.

C



The powerful, easy-to-handle Buckeye Hi-Frequency Sander. It's ideal for automotive and industrial applications where tools are subjected to continuous, heavy duty service. R & M furnishes motors to Buckeye Tools Corporation in capacities from 3/16 to 4 HP.

D

The IBM Executive made by International Business Machines Corp., the only typewriter manufacturer exclusively producing electric machines. It's the mark of a modern office!

Can YOU match these motors to these tools and machines?

Here are some R & M fractional horsepower motors, and the machines for which they were selected or designed. Can you guess which goes with which? The answers are printed at the right . . . what was *your* score?

THE ANSWERS

R & M motors and motor parts, and the machines on which they are specified as standard, match up as follows:

1-C 2-A 3-D 4-B

ON COMPLETE MOTORS OR MOTOR PARTS . . .

Don't "guess" . . . let Robbins & Myers do a *scientific* job of matching the all-important motor to your product! Regardless of whether you need a motor that's standard or custom-designed . . . motors with special housing designs or motor parts to fit your housings, remember that R & M Motors are powering all types of equipment, such as . . . . . .

Portable Saws
Drills
Nut Setters
Hammers
Routers
Screw Drivers
Hedge Trimmers
Lawn Mowers
Nibblers
Lock Mortisers
Valve Grinders
Vacuum Cleaners
Files
Sanders
Pumps
Compressors
Hones
Business Machines
Cast Cutters
Food Mixers
Polishers
Planers
Portable Grinders
Sirens
Hair Driers
Advertising Devices
Ventilating Equipment
Oil Burners
Surgical Instruments
Grease Guns
Vibrators
Die Sinkers
Waxers

why you get better performance from a Fractional Horsepower Motor that's matched to your machine!

The most important single factor in the performance of any motor-driven product is the *motor itself*. That's why the engineers who designed the well-known tools and machines at the left came to Robbins & Myers to get the *right motor for the job*. Like many other R & M customers, they knew that the motor which met *every requirement*—one by one—was bound to improve the performance of their products, and *last longer* as well.

Selecting such a motor isn't simple. You can, of course, *look* at these examples, and try matching the motor to the machine for which it was designed. It's easy to guess, but in your business you can't afford guesswork.

Neither can we. That's why we've set up such systematic methods for designing motors. For example, we often use the R & M "Electrical Slide Rule." In this unique machine we first set up the electrical equivalents of motor *operating conditions;* then test equivalents of various motor *designs.* Result? Required motor characteristics can be calculated in minutes instead of days!

In some cases, the answers point to a standard motor. We have many such motors to choose from. But in other cases where special motors are indicated, we can do a fast, thorough, economical job of custom-designing a motor that's *exactly right* for your product.

In short, our experience—and our approach to your problem—isn't limited to standard motors we have "on the shelf."

If you feel that the motors you're now using aren't 100% right—in quality or in performance characteristics—we can make a real contribution to the solution of your problem. Use the coupon below . . . you will get the information you want promptly.

if it's an R&M it's the Right Motor!

ROBBINS & MYERS, INC.

SPRINGFIELD 99, OHIO • BRANTFORD, ONTARIO

ROBBINS & MYERS, INC., MOTOR DIVISION, SPRINGFIELD 99, OHIO: PD-73

Please send me, without obligation, information on:

- ☐ Motor Parts for Portable Tools
- ☐ Universal Motors
- ☐ Capacitor Motors
- ☐ Universal and DC Motors
- ☐ R & M "All-Weather" Motors—up to 125 HP
- ☐ Please have a Motor Specialist call

Product we manufacture: _____

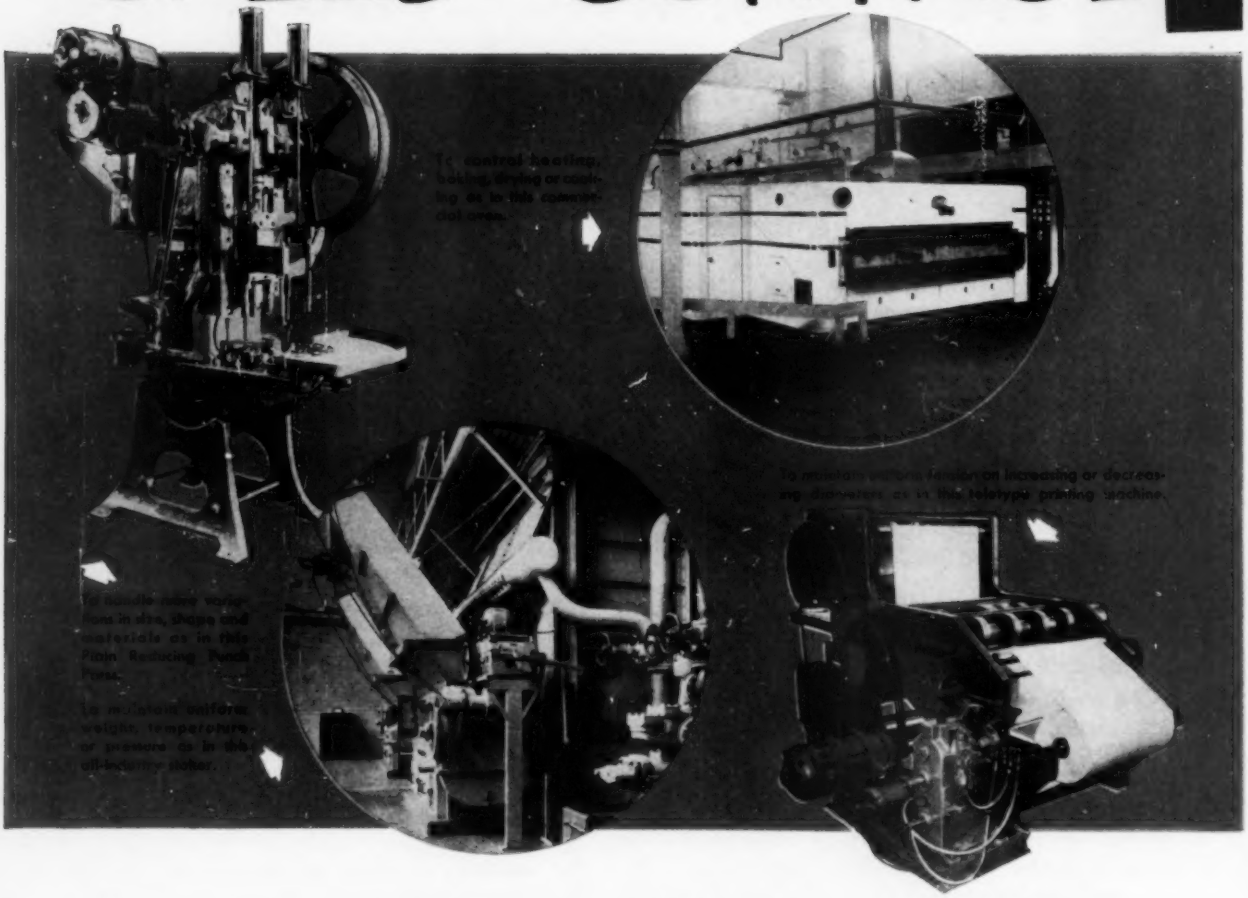
Name _____ *Title* _____

Company _____

Street _____

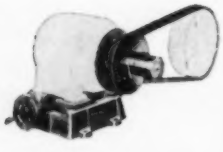
City & State _____

REEVES SPEED CONTROL

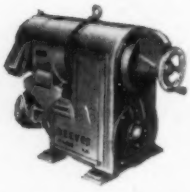


Choose from the complete line — REEVES!

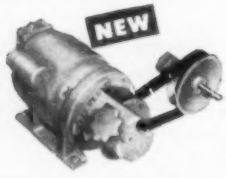
Variable Speed Transmission for providing infinite, accurate speed flexibility over a wide range —2:1 to 16:1. Especially adaptable for heavy duty applications. Sizes from fractional to 87 hp.



Vari-Speed Motor Pulley converts any constant speed motor to an accurate, variable speed drive with 4:1 ratio. Rugged, dependable—sizes to 10 hp. VARI-SPEED JR. available for light machinery.



Metadrive combines motor, speed varying mechanism and reduction gears in single, compact unit. Speed variations 2:1 to 6:1. Sizes to 25 hp. Also available in fractional sizes with 10:1 ratio.

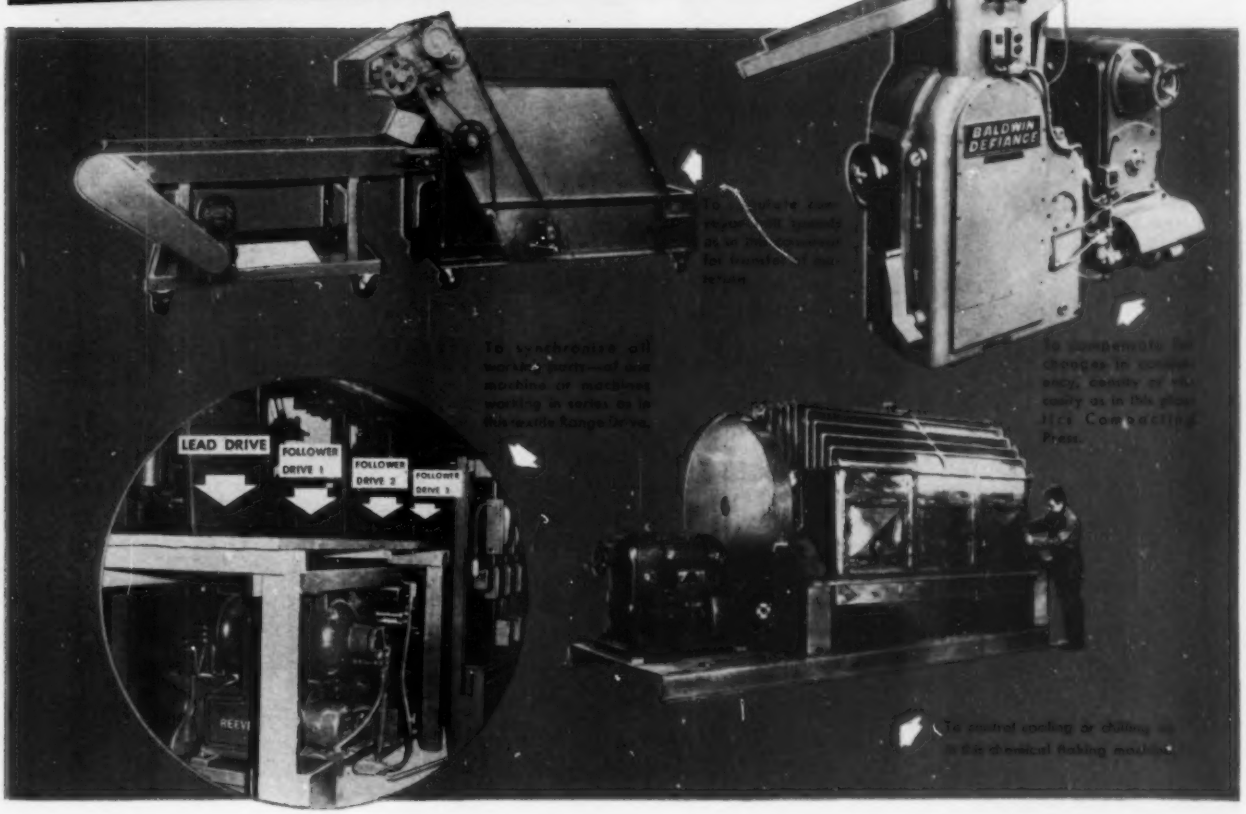


Flexi-Speed Drive is the most versatile, most economical variable speed drive with 8:1 speed range. Mounts in any position . . . drives in any direction. Available in ½, ¾ and 1 hp.

REEVES PULLEY COMPANY, COLUMBUS, INDIANA

Recognized leader in the specialized field of variable speed control.

is standard equipment on 2750 different makes of machines!



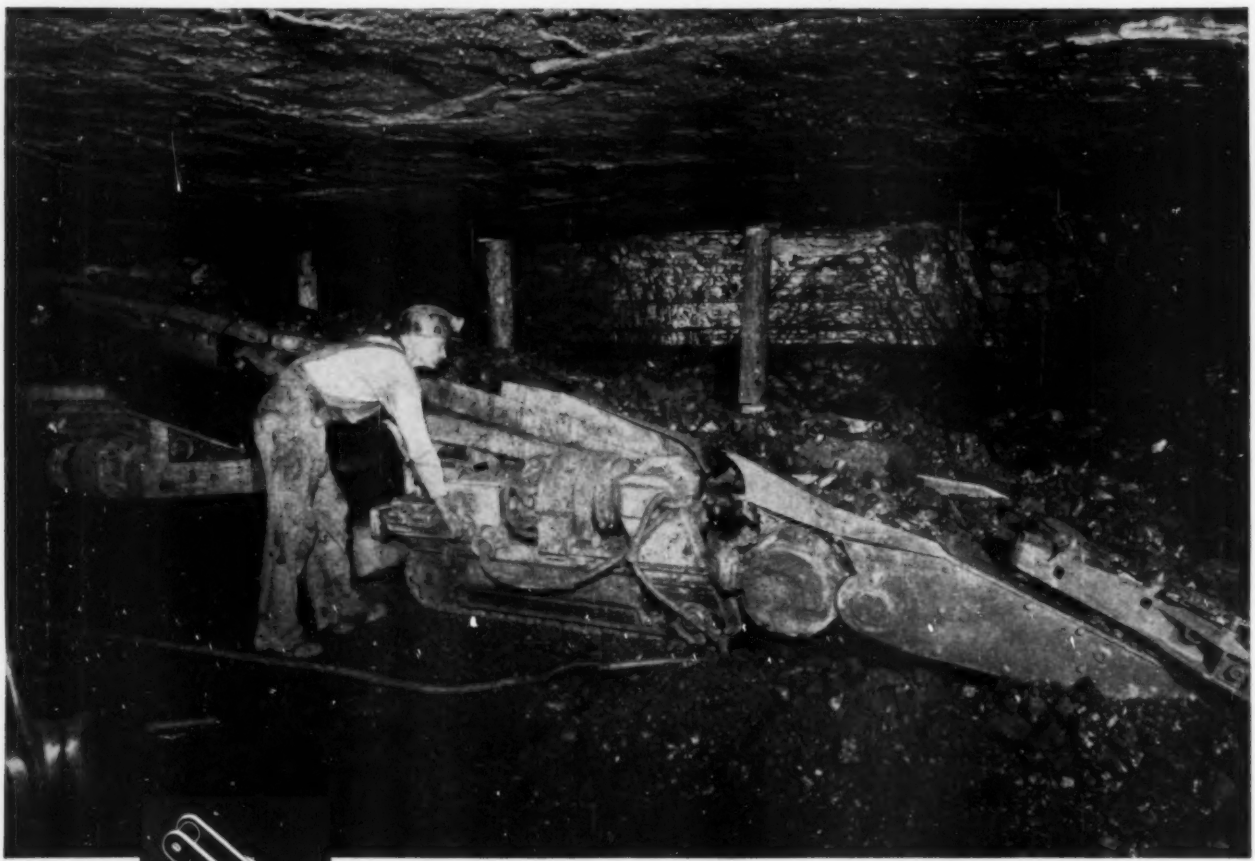
Make the machines that you design or build more flexible, more productive, more salable, with REEVES Variable Speed Control as standard equipment. REEVES provides the *full* range of stepless speed adjustability necessary to handle all the variations in speed and timing required for different materials, sizes, shapes, processes, operators . . . simply by the touch of a button or the turn of a handwheel.

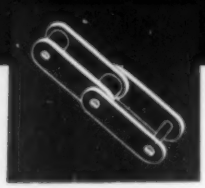
Whatever the specialized variable speed requirements of your machines, the *complete* REEVES line has the equipment you need . . . with your choice of manual, electric or completely automatic controls. The use of REEVES as standard equipment by the manufacturers of 2750 different machines speaks for REEVES accuracy and dependability. Let one of the REEVES engineers—strategically located throughout the United States and Canada—show you how one of the four basic units in the REEVES line can be built into your equipment or installed on it. Write today to Dept. K98-3N for 132-page catalog.

REEVES
SPEED CONTROL

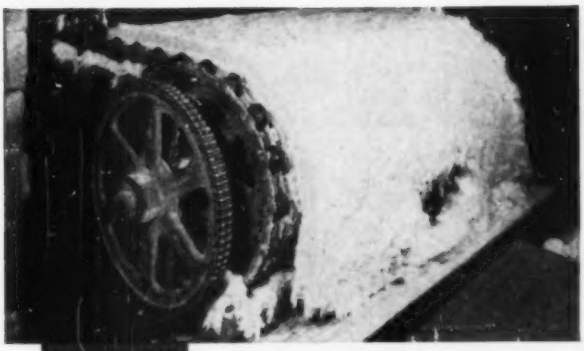
What is the right chain for your drive or conveying job?

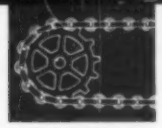
You'll find the answer in LINK-BELT's complete chain line... a size and type for your specific job



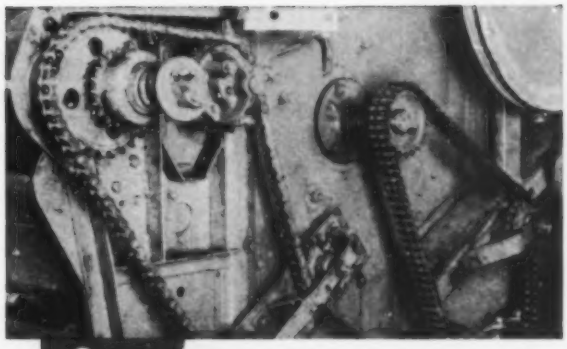


COAL LOADER handles large tonnages underground. To convey the coal Link-Belt Precision Steel Roller Chain, fitted with special attachments, is used. Selected because of its extra strength, it assures long life under the wet, abrasive conditions prevalent in most mining operations.

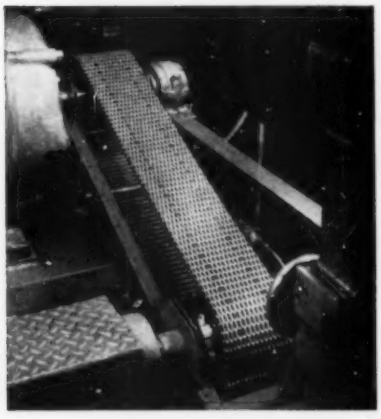


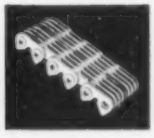


CHEMICAL and allied industries are served by Link-Belt drive and conveyor chains and sprockets. Class SS roller-type chain and Precision Steel Roller Chain appear on this mineral wool conveyor.

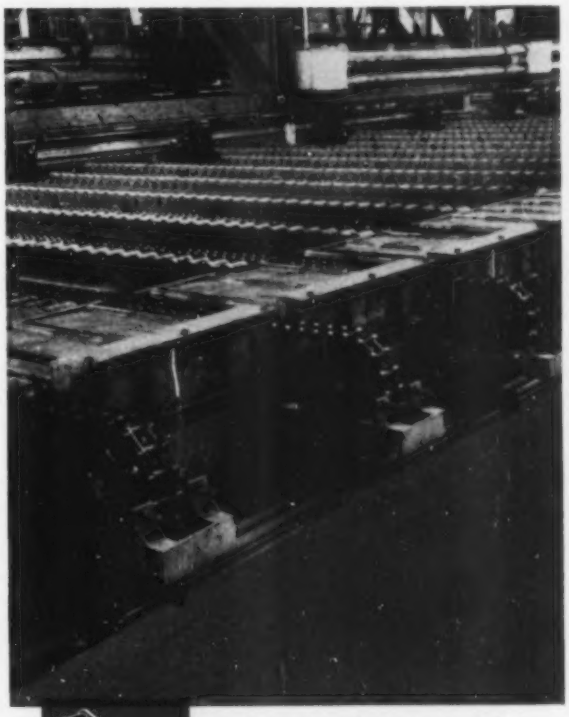


AGRICULTURAL MACHINES use Link-Belt chain for both drive and conveying service. On this combine, single and multiple-width Link-Belt Precision Steel Roller Chain drives were chosen.





PRINTING PRESS manufacturers utilize Link-Belt Silent Chain drives on the majority of the company's high-speed, high production presses to insure accurate register.



METAL WORKING plants rely on Link-Belt chain for many tough jobs. Here Class C combination chains with outside rollers feed brass bars into cold-rolling mill.

INDUSTRIAL TRUCKS, such as this high-lift model, call for the built-in dependability of Link-Belt Precision Steel Roller Chain.

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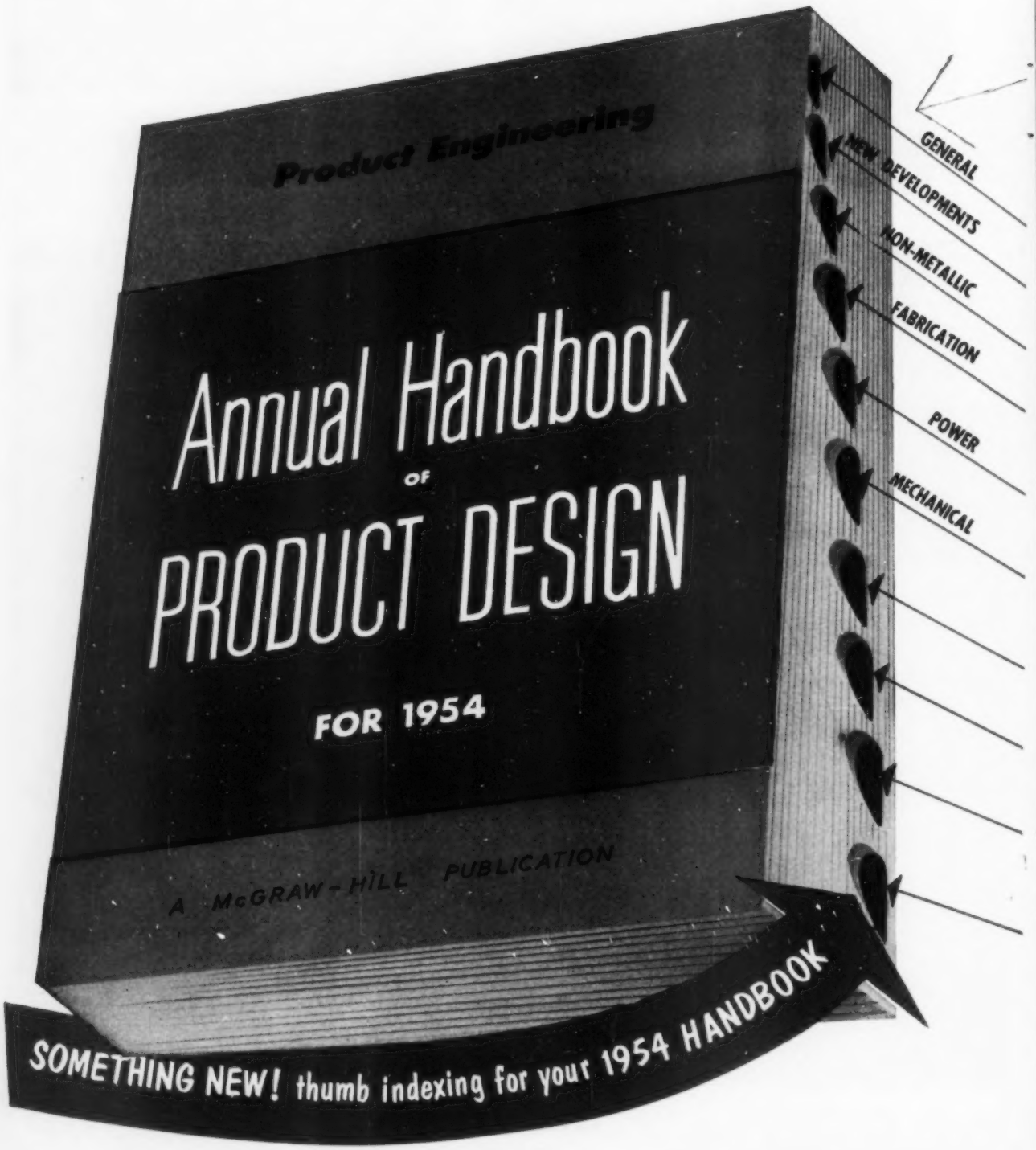

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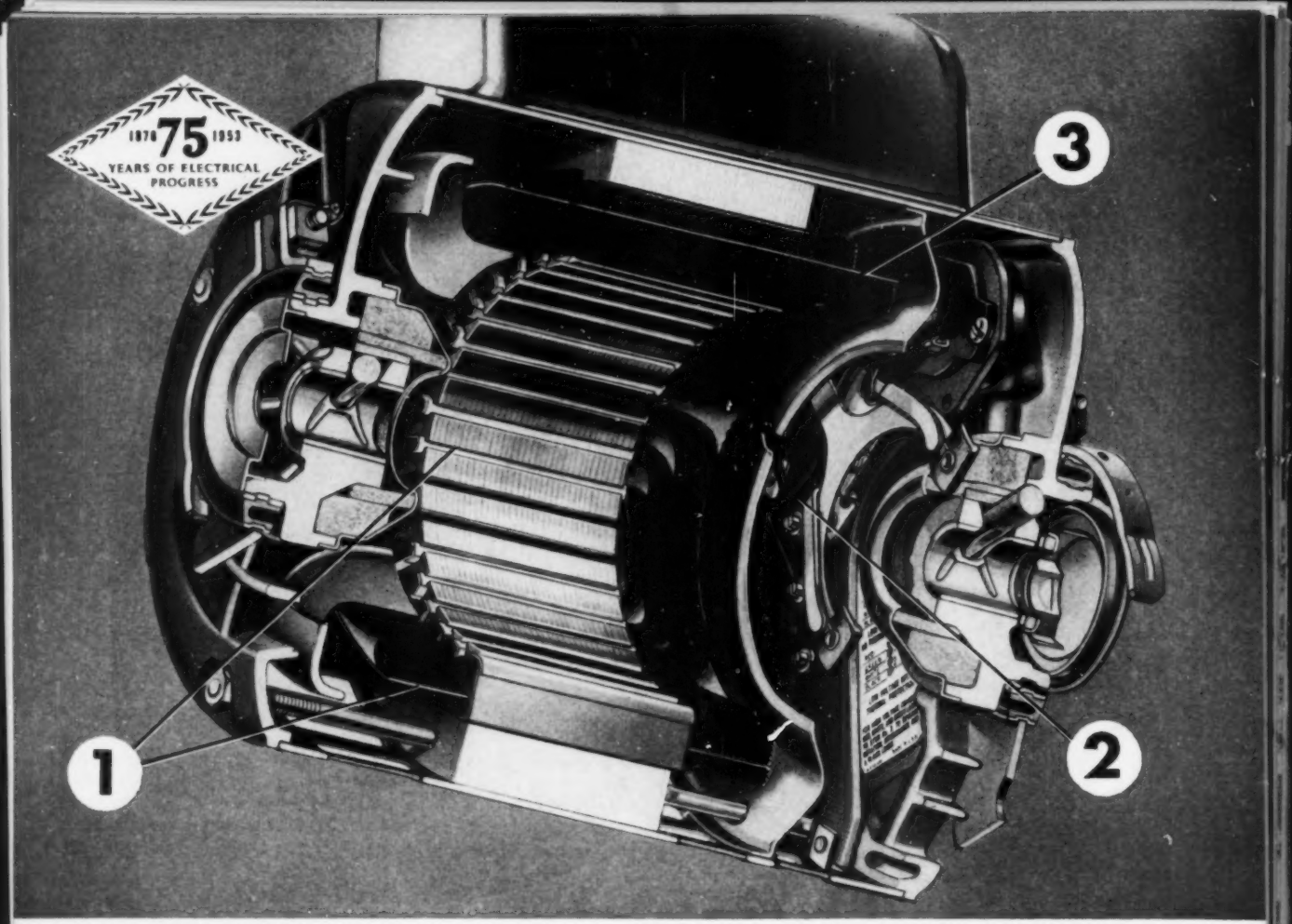

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General Electric's new Fhp motor is the first to offer the superior insulation qualities of DuPont Company's "Mylar" Polyester Film. An insulator that raises the safety factor of everyday motor operation while contributing to greatly increased motor life through improved insulation. "Mylar" in combination with G.E.'s already proven Formex wire, braidless Neoprene leads and Glyptal varnish now offers you the most advanced type of motor insulation. An insulation system that means better motor protection . . . longer motor life even under abnormal conditions.

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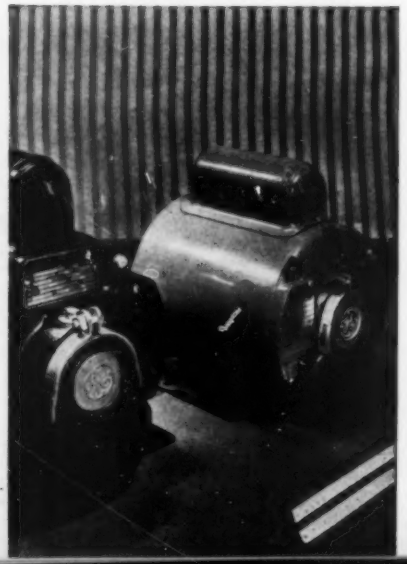

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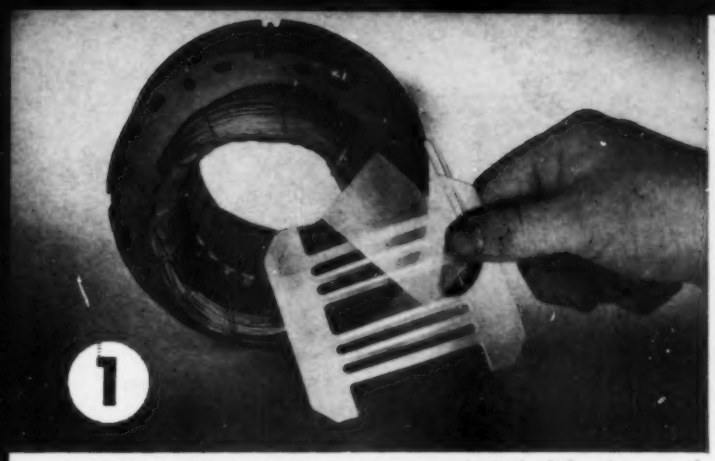

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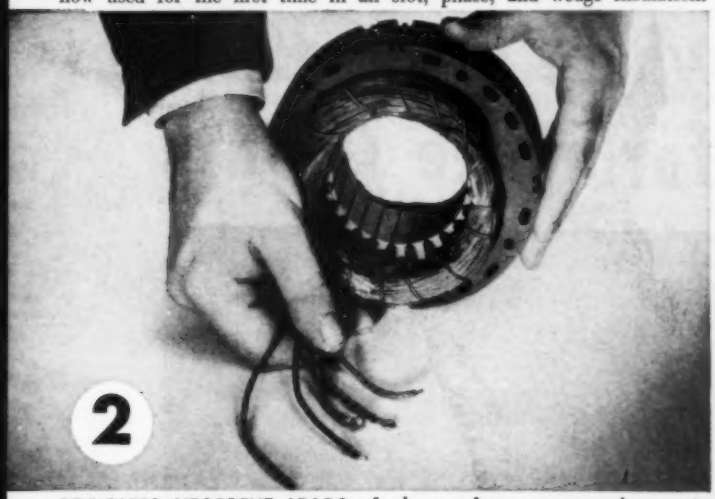
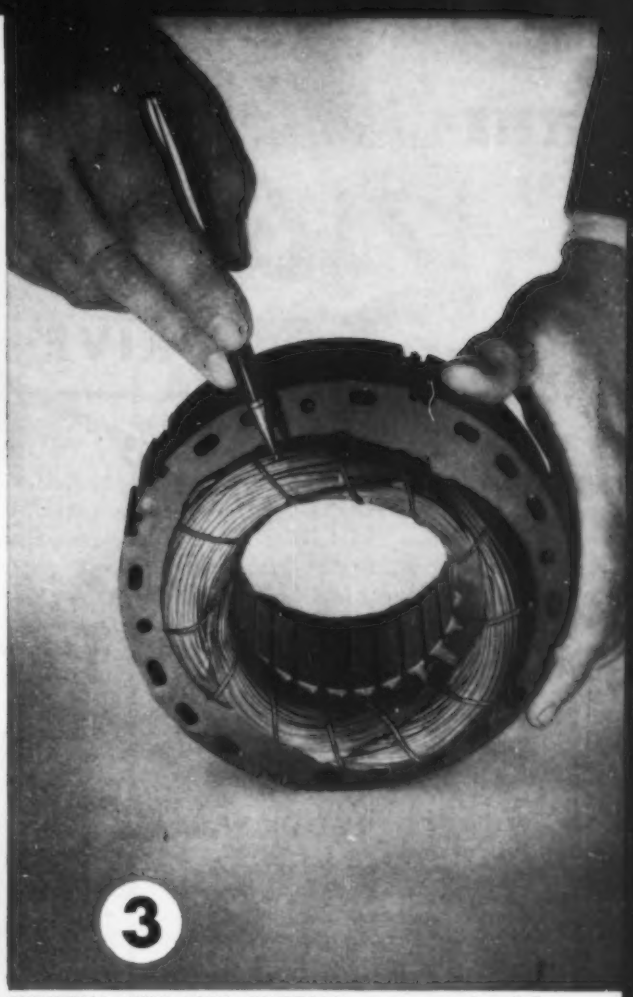


BRAIDLESS NEOPRENE LEADS of clear and permanent color retain high insulation strength and flexibility under severe operating conditions.



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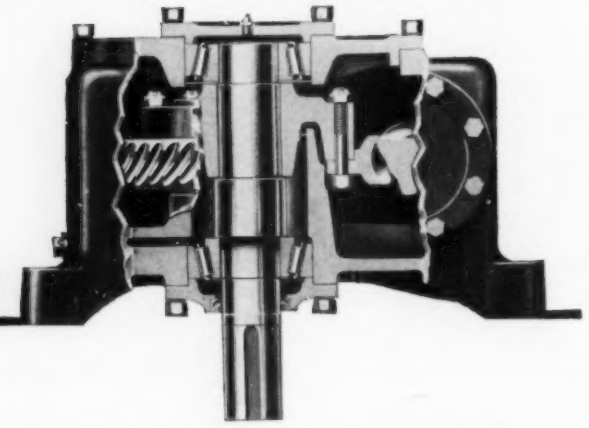

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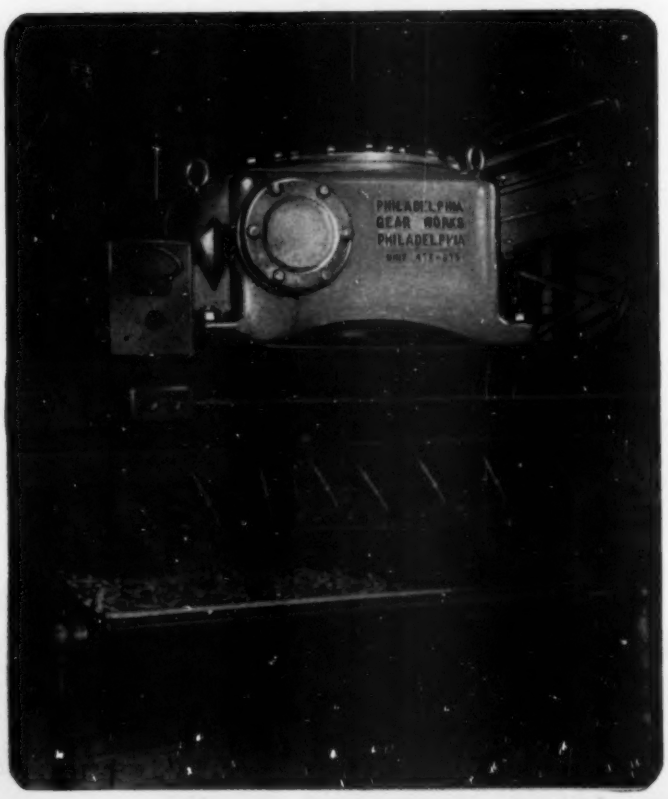
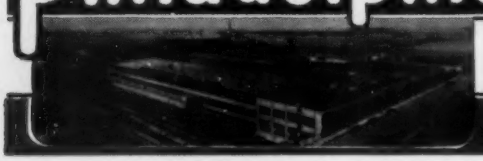


For full information on Philadelphia Worm Gear Speed Reducers, write for catalog WG-51.

Philadelphia Gear Works, INC.



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Perspectives ~ DESIGN AND DEVELOPMENT

PRECISION SERVO MARKET

During the past ten years, high precision servo equipment has grown from a laboratory curiosity to the basis of a multi-million dollar industry shared by about 400 participating companies. Urgent military needs have encouraged the advancement of design and sizable production facilities. Such equipment is used in a variety of military applications that require extremely accurate speed or position control like aircraft navigation, artillery fire control, radar tracking.

There's been only one blot on an otherwise rosy picture. The United States government remains the industry's sole customer. All gear has been designed to meet demanding military specifications without any thought of possible commercial application.

Now suppliers are facing an economic crisis. As defense production levels off and mobilization goals are reached, it appears that there isn't going to be enough military business to keep all 400 busy. More and more companies are asking this question: Are there enough commercial applications for high precision servo equipment to take up the slack in design and production facilities?

NOT COMMERCIAL

Many observers say no. They predict a high mortality rate, particularly among the smaller companies, when defense spending dries up. Here's the kind of arguments you hear:

- Most of this equipment, designed for rigid military specifications, is overdesigned for commercial use. It's too expensive, too well built. The problem becomes who in industry needs servo equipment that can operate at –65F, withstand the vibration of heavy artillery firing, and weather rough combat handling.
- Because many applications of such gear have been classified by the military, industry as a whole is unacquainted with it and its functioning. Somebody will have to do plenty of educating before most design engineers will consider such equipment for inclusion in their own products.
- There's a maintenance problem involved, too. The military has spent a fortune training technicians and specialists to service this electronic gear. Industry has no such technicians available; companies might be hard pressed to afford the costly maintenance program required.
- Industry does not have many operations that require the accurate degree of control possible with high precision servos.

THE OPTIMISTIC VIEW

Servo manufacturers, on the other hand, feel more optimistic about the future. They think there might be at least three fields with large scale potential for them: atomic energy control, factory automation and guided missiles. All look good on the surface, but none is ready for immediate exploitation.

It appears now that atomic energy power plants will have to be automatically controlled in order to protect operating personnel. That might open up applications for electronic servos (however process industry control people feel that their pneumatic, electrical, and hydraulic units will have the inside track). In addition, the whole subject of power generation by atomic energy is so new and so unproved that no one can predict what unexpected applications might open up. To illustrate what they mean, industry spokesmen cite the driverless fork lifts at some AEC installations. Guided by a television camera mounted on the machine, an operator, many hundred yards away, runs it by means of a complex servo system.

(Continued on page 137)

THIS FLEXON BELLOWS ASSURES PRECISE, DEPENDABLE CONTROL WITH THIS FLOW SWITCH !

Thermostatically controlled flow switch manufactured by Power Engineering & Equipment Co. which incorporates a ¾" I.D. Flexon Bellows.

Flexon Bellows offer the designer and the manufacturer an ideal combination—high standards of uniformity coupled with the manufacturing economies of standardized production. In over fifteen years of bellows manufacture, Flexonics Corporation has developed manufacturing techniques that permit the fabrication of a wide variety of bellows as standard production items. Using these methods assures exact compliance with your specifications . . . assures you that the Flexon Bellows will "fit" your product to avoid assembly headaches . . . assures you of the type of performance your product is designed to give.

Flexon Bellows are offered in a complete range of sizes in brass, bronze, stainless steel, monel and other alloys. For any thermostatically controlled device, it will pay for you to consider Flexon. For recommendations send an outline of your requirements.

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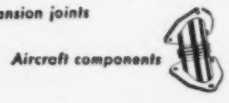

AUTOMATION

Factory automation represents the biggest potential market for this equipment. Although servo builders would like to interest two fields, process industries and metal working, neither is amenable to the idea of using precision electronic servos for automation.

In chemical processing, automatic manufacturer has been an established fact for over twenty years. There are well established controls, usually pneumatic with some electrical or electro-mechanical gear. Chemical engineers are not eager to switch to electronic gear.

The main reason: many processes deal with inflammable or explosive materials. That's why pneumatic controls are so popular. Processors don't want to add any equipment that might introduce a hazard through electrical sparks, short circuits or overheating. In addition, there's a certain amount of inertia connected with any large scale change.

The metal working industry is not yet ready for complete automation. Typical present day obstacles: 1) equipment is not suitable; 2) capital investments required are too high; 3) and philosophic problems—like what to do about labor—are blocking the project.

TOOL BUILDERS' RELUCTANCE

Nevertheless, servo people think that machine tool builders are their best potential customers. Machine tool operation—with its changing feeds, speeds and tolerances—probably is the closest thing to the military applications that use precision servos. But the builders have not been impressed even by such unique developments as the MIT computer controlled milling machine or the similar machine tool control developed by scientists at the Lewis Flight Propulsion Laboratory to shape turbine blades.

Reticent to go along with precision servos, machine tool builders have a strong argument. They can't see where they might sell tools so equipped. In addition, they claim that today's machine tools have everything that users want; or, more exactly, have everything that users are willing to pay for.

However, if suppliers can't sell their products into plant facilities, they still may be able to reach the office. Management specialists predict that high speed computers and electronic business machines will replace many current office techniques. Some precision servo components could be used in this type equipment; others might be modified slightly for such use.

One other possible application frequently mentioned for precision servos is guided missile or rocket control. These devices require a degree of control rarely encountered in any other field.

WHO'S INVOLVED

Two types of companies are interested in the future of precision servos, those making components, and those using components to build complete systems.

Many of the big companies who make complete systems got into this work because it afforded tremendous development and research possibilities that might affect their commercial lines, and because it represented a large amount of business. With their conventional commercial products to fall back on, they will probably be little affected by the loss of military precision servo business.

Many of the smaller companies have no such prospects. Drawn into the field by huge government demands and the prospects of government contracts or subcontracts, they make only one component. They have no commercial experience, no distribution, and little idea of industry's requirements.

It is among these companies that observers fear the heaviest mortality rate. But it looks like it will depend on what the company has in the way of marketing sense and product. For instance, there's apparently a rosy future ahead for one supplier who had concentrated on making simple plug-in components with built-in electronic tube failure prediction units. His components can be used in a variety of commercial equipment.

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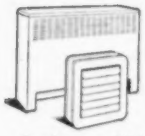
SPEED NUTS® are one-piece, self-locking, spring steel fasteners. Snap over panel edges or center hole locations . . . self retained in screw-receiving position for easier, faster assembly in "blind" locations. Available for a full range of screw sizes and panel thicknesses.

SPEED NUTS Saved 6,144 Assembly Hours, Thousands of Production Dollars

Reports the Trane Co., La Crosse, Wisconsin



"Every time we use a SPEED NUT, we save 14 seconds in production time", say Trane engineers. In one year, this leading manufacturer of air conditioning, heating and ventilating equipment netted 6,144 extra assembly hours, plus amazing savings in materials and materials handling. Misalignment of ventilator weld nuts and mounting holes slowed production continuously. Replacing them with "U" type SPEED NUTS, which snap in place by hand and provide floating alignment, ended this bottleneck. Costly installation of convector heater coil headers was overcome with "J" type SPEED NUTS. Snapped directly on frame members, they eliminated eight cast iron drilled and tapped ears and two welded support brackets. SPEED NUTS, applied after painting, eliminated masking or retapping of threads—licked rust problems.

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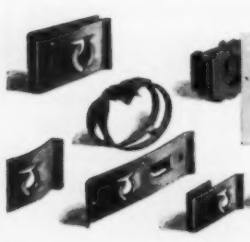

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SADI CARNOT, artist and poet, sitting in his Paris garden day-dreamed about the crude steam engines that were beginning to be used. By philosophical reasoning and no mathematics, Carnot deduced his famous, "Carnot Cycle Efficiency" theory. He wrote a small leaflet in which he set forth his reasoning and had a copy placed in the library of Paris.

About forty years later the great German mathematician, Clausius, was browsing through the library of Paris and happened to come across Carnot's essay. It took only a few minutes for him to read it. He became interested, questioned the theory, applied mathematics and proved conclusively that Sadi Carnot was correct. Thus was born the famous equation now known as the Carnot Cycle Efficiency. Mathematics had converted a theory into an engineering tool.

Stefan working in his laboratory tried to establish the relationship between absolute temperature and radiant heat energy. He finally determined experimentally that "The intensity of the radiant energy is proportional to the 3.86 power of the absolute temperature", and guessed that the correct figure must be the fourth power. "In black body radiation the intensity of the radiant heat energy is proportional to the fourth power of the absolute temperature", became known as Stefan's law.

Again a great mathematician stepped into the picture. This time it was the Austrian Dr. Bolzmann. Using mathematics he proved that Stefan's guess was right and thus we have "Bolzmann's proof of Stefan's law". Mathematics had converted a guess into a certainty.

In developing the atom bomb mathematicians had calculated the size of the "critical mass". A piece of fissionable material of greater mass "explodes". A smaller mass cannot possibly "explode". Chicago might well be a sorry mess today if the mathematics had been in error.

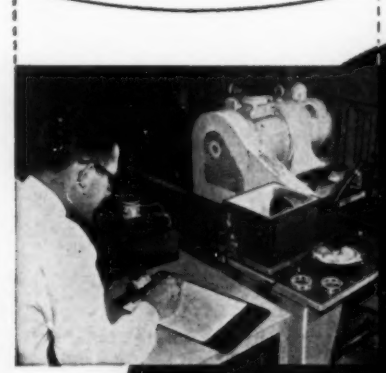
Mathematics is the foundation for many of the calculations in design. All the beam-strength formulas require calculus for their derivation. Thick walled cylinders, flat plates, rotating shafts and hundreds of other machine elements must be calculated with equations based on higher mathematics.

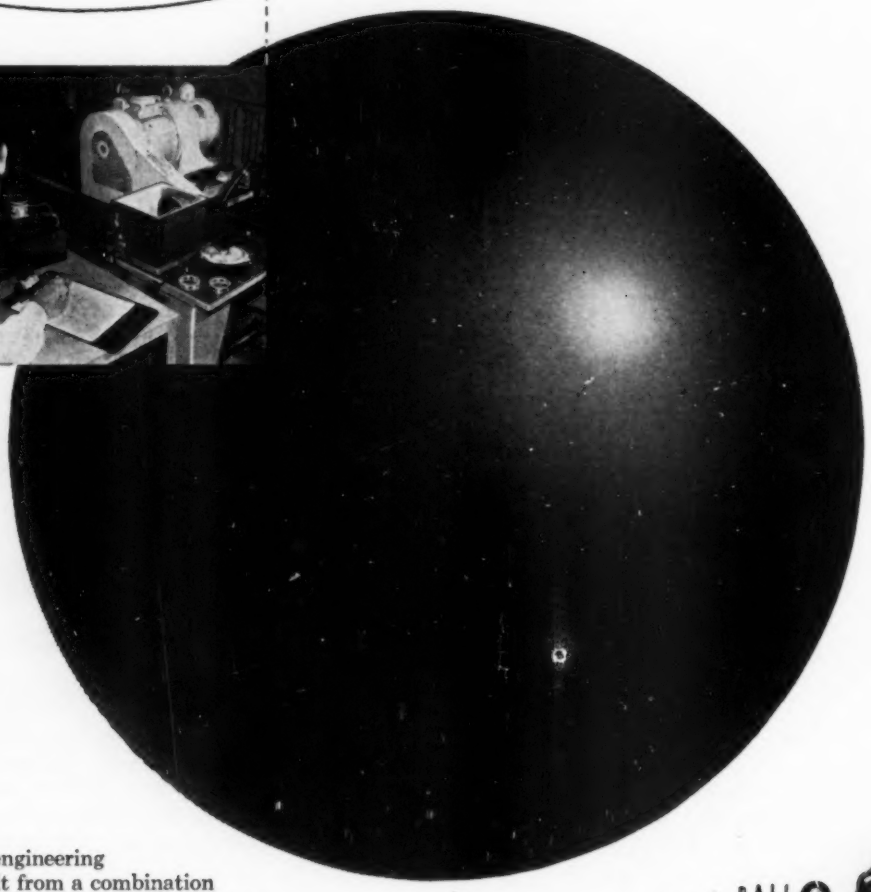
Without mathematics we would still be in the dark ages. The history of civilization parallels the history of mathematics. The glories of Egypt, Greece and Rome would have been impossible if it had not been for the abilities of those peoples to reason mathematically. The pyramids, the irrigated Nile valley, the architecture of Greece, the arches, aqueducts and roads of Rome were not built by cut and try. They testify to the mathematical abilities in civilizations of another age.

Mathematics becomes an obsession to some people. They attempt to use higher mathematics where simple arithmetic suffices or a quick experiment will give the answer. To go to excesses is the most common human failing. Because some people do not know when to use mathematics and when to experiment does not in any way detract from the worth of either. Often both are required. But mathematics will always be the most powerful weapon for unravelling the secrets and mysteries of nature.

George F. Jordenkolt.

Engineering Excellence





New Departure's engineering achievements result from a combination of many talents and techniques. From never-ending research to application advice with 60 years of experience behind it, every resource of New Departure is aimed directly at engineering excellence.

High manufacturing standards hold tolerances, in many instances, to limits measured in millionths of an inch. Scientific inspections make certain that component parts, as well as completed bearings, will perform as prescribed.

New Departure products are found wherever the forces of friction must be defeated. Miniature bearings for delicate instruments or large units for industrial installations, and anything in between, can be supplied by New Departure. Keep your eye on the BALL to be sure of your BEARINGS!

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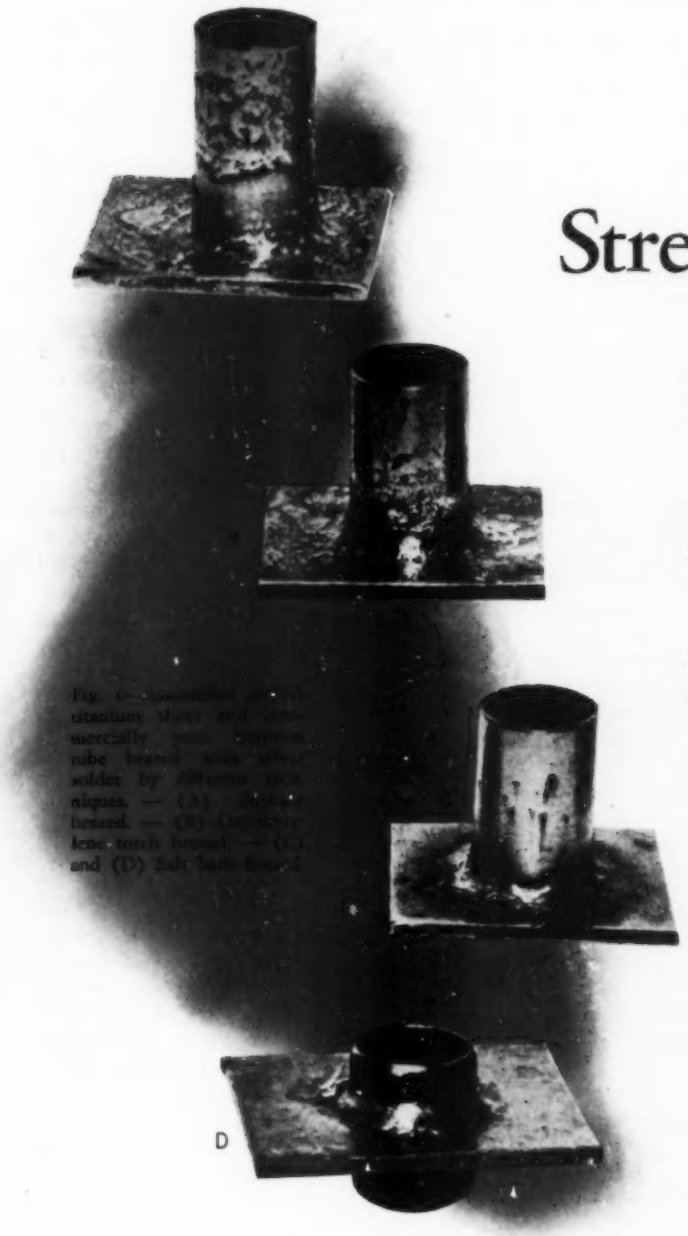

Fig. 6 — [illegible] titanium sheet and commercially pure titanium tube brazed with silver solder by different techniques. — (A) [illegible] brazed. — (B) Oxyacetylene-torch brazed. — (C) and (D) Salt bath brazed.

Strength of Joints in Titanium Brazed With Several Alloys

Strength, stress-rupture and fatigue properties of single lap and double lap joints of titanium sheet brazed with silver base and aluminum base brazing alloys. Data include test results obtained from specimen joints prepared by both slow and rapid heating techniques.

L. W. SMITH
L. A. YERKOVICH
Metallurgy Section
Cornell Aeronautical Laboratory, Inc.

URGED ON by the trend toward using titanium, with its high ratio of strength to weight, for structural components in aircraft, a program sponsored by Bureau of Aeronautics, Navy Department was instituted at Cornell Aeronautical Laboratory to survey materials and methods suitable for brazing titanium. In particular, the purpose of the investigation was to study brazing alloys and to develop brazing techniques for joining sheet and bar titanium that would result in optimum joint strength properties.

The important conclusions that resulted from this project are:

1. Titanium can be brazed using the common commercial techniques when it is suitably fluxed and properly protected from the atmosphere.

2. Present commercial fluxes for titanium brazing limit the selection of brazing alloys to those with melting points below 1450 F and above 1100 F approximately.

3. Salt bath brazing of titanium, while quite satisfactory for small sections, presents considerable difficulty when the mass of jigs and fixtures to be heated is large.

4. Both aluminum and silver base brazing alloys form compounds with

titanium during brazing. These compounds are thought to be brittle and affect the consistency of strength in single lap joints. On the basis of strength consistency alone, the presence of these compounds is not important in double lap joints that are subjected mainly to shearing stresses.

5. While erratic strengths are obtained in single lap joints brazed with aluminum and silver base alloys when heat is applied slowly, such as in regular torch and furnace techniques, more reliable and stronger joints are produced by rapid heating methods. It is believed that rapid heating restricts the formation of compound, thus reducing the effect of the compound on the consistency of joint strength.

Titanium is a rather inert metal at ordinary temperatures. At 1300 F, however, titanium readily forms adherent and relatively impermeable oxide and nitride coatings. Oxygen, nitrogen, and hydrogen are embrittling to titanium and therefore should be avoided for optimum mechanical properties. The brazing of titanium, therefore, presents two major problems:

1. Prevention of formation of oxides, nitrides, and hydrides so that metallic or atomic bonding may be formed during brazing.

2. Prevention of titanium embrittlement caused by gas contamination.

Test Program

After unsuccessful preliminary trials of brazing titanium with several commercial silver solder fluxes, it became evident that unless titanium can be properly shielded from the atmosphere, bonds cannot be formed by the common brazing processes.

To shield them from the atmosphere, titanium sheets were electroplated with nickel, silver, cadmium, tin, zinc, copper and brass. Some experiments were made with these coated sheets to determine if they could be satisfactorily brazed or soldered using conventional materials and methods.

Because of the low melting points of cadmium, zinc and tin, attempts were made to join coupons plated with these metals using soft soldering techniques. With these, soft soldering was successfully accomplished.

Torch brazing techniques and standard fluxes for silver soldering steel or brass were tried with the remainder of the plated coupons. In this series, the copper plated titanium seemed most promising so far as ease of brazing, alloy flow and joint strength are concerned.

Even though the plated coupons were heated by a hand oxy-acetylene torch to temperatures at which titanium is very reactive with gases, no indication of gas attack was observed.

Because of the facilities required to electroplate before the brazing operation and to strip the coating after the operation, however, this method of protecting titanium is somewhat impractical.

The conjecture that these electroplated coatings might diffuse into the titanium to produce hard cases was sufficiently interesting to warrant a simple heat-treating experiment. Coated coupons, therefore, were heated in a commercially pure argon atmosphere to temperatures just below the melting point of their plated coatings. Subsequent hardness measurements, however, failed to note the presence of any new phases worth study for case hardening characteristics.

Indications were that small increases in hardness could be attributed to pickup of nitrogen and/or oxygen from the argon.

Through a country-wide survey of titanium brazing activities, it was learned that Handy and Harman were developing a titanium brazing flux. In Fig. 1 are shown titanium sheet and tube assemblies brazed by various methods using this flux.

The cross section of a salt bath brazed specimen, shown in Fig. 2, reveals the type of bond and the adequate flow of silver base brazing alloy between the sheet and tube. The unprotected titanium becomes undesirably discolored and scaled during exposure to heat. Subsequent cleaning, however, as recommended by Titanium Metals Corporation of America, Ref. 1, results in a clean bright finish.

Test results of torch brazing with silver base brazing alloys and the Handy and Harman flux proved sufficiently satisfactory to warrant further study with silver and aluminum base alloys. Consequently, several such alloys were selected and investigated not only for their suitability as brazing materials but also to acquire an understanding of the bonding mechanism between titanium and the various alloys. The nominal chemical compositions of the brazing alloys selected are given in Tables I and II along with identifying letter designations.

A series of brazed titanium lap joint specimens were prepared and tested for joint strength and manner of failure.

Joint preparation consisted of grind-

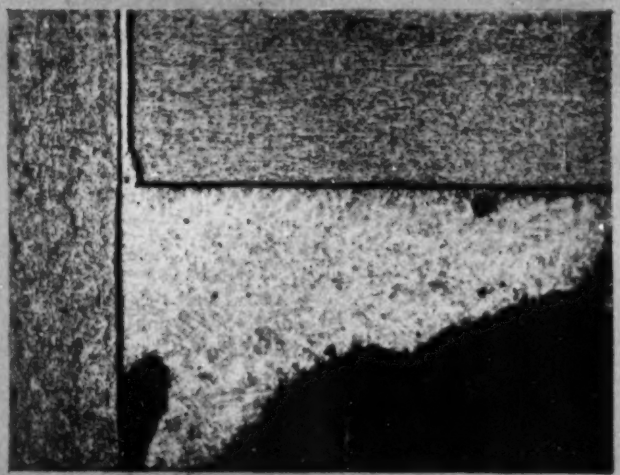

Fig. 2—Cross-section (50X) of 75A titanium sheet brazed with silver solder to commercially pure titanium tube using salt bath brazing technique.

Table I—Nominal Composition of Silver Brazing Alloys

Designation	Ag	Cu	Zn	Cd	Mn	Ni
A	45	15.0	16.0	24		
B	64	18.0	18.0			
C	50	15.5	16.5	18		
D	65	20.0	15.0			
E	80	16.0	4.0			
F	65	28.0			5.0	2.0
G	75	25.0				
H	Composition unavailable.					

Table II—Nominal Compositions of Aluminum Alloys

Designation	Cu	Mg	Mn	Si	Cr	Al
J				5.0		Balance
K	0.25	1.0		0.6	0.25	Balance
L						99% min.
M			1.2			Balance
N	4.5	1.5	0.6			Balance

Table III—Joint Strength of Silver Solders in Lap Joints of Titanium Sheet Prepared by Oxy-Acetylene Torch

All specimens were single lap joint type except specimens 5 to 9 inclusive brazed with alloy G which were double lap joint type.

Joint area of all specimens was 0.5 square inch.

In all specimens the alloy flowed by capillary action except in specimen 5 brazed with alloy A and in specimen 3 brazed with alloy B which were tinned before joining.

Brazing Alloy	Specimen	Joint Load, lb	Joint Strength, psi
A	1	4620	8778
	2	4000	7660
	3	3280	6840
	4	4310	8135
	5	5500	9975
B	1	3520	6510
	2	5580	10,600
	3	5770	10,960
C	1	3090	6310
	2	4520	9230
	3	5680	11,360
D	1	3200	6160
	2	2690	5490
	3	3000	6000
	4	3780	7560
E	1	2790	5810
	2	3480	6960
	3	3110	6760
	4	3030	5830
F	1	1640	3150
	2	1770	3470
	3	1490	2980
	4	2280	4560
G	1	2670	5800
	2	3130	6390
	3	2870	5740
	4	5790	*
	5	5880	*
	6	6000	*
	7	6200	*
	8	5990	*
	9	5880	*
H	1	2360	4455
	2	2000	4000

*Failed in titanium sheet.

Table IV—Joint Strength of Aluminum Base Solders in Single Lap Type Joints of Titanium Sheet Prepared by Oxy-Acetylene Torch

Joint area of all specimens was 0.5 square inch.

In all specimens the alloy flowed by capillary action.

Brazing Alloy	Specimen	Joint Load, lb	Joint Strength, psi
J	1	1910	3605
	2	1960	3920
	3	3250	6250
K	1	1930	3860
	2	3780	7560
	3	5650	10,660
L	1	4300	8960
	2	3330	6660
	3	3720	7440
	4	3240	6480
M	1	2940	5880
	2	2520	5040
	3	2640	5280
	4	3760	7520
N*	1	980	1960
	2	1000	2000

*Tested in as-cast condition

ing, fluxing, and clamping together the surfaces to be joined. Heat was applied to the clamped assembly and the joint formed by capillary flow.

Specimens with the various silver base brazing alloys were prepared by oxy-acetylene torch brazing using titanium brazing flux No. 29. When brazing with the aluminum base alloy, flux No. 110 was used. Flux No. 110 has a lower melting point than flux No. 29 and is more suited for lower melting point alloys.

Single lap specimens were 1 by 4 by 0.064 in. commercially pure titanium with $\frac{1}{2}$ in. overlap.

Double lap specimens were 1 by 3 by 0.064 in. RC 70 titanium overlapped $\frac{1}{2}$ in. on each side of a middle strip of 130 A titanium, the high tensile strength of which insured failure in the joint.

Double lap joints with nominal joint areas identical with those of the single lap joints were also prepared.

Test results giving the joint strengths of specimens brazed with silver base solders are given in Table III. Test results giving the joint strengths of single lap specimens brazed with aluminum base solders are given in Table IV. No indication of the joint strength of the double lap

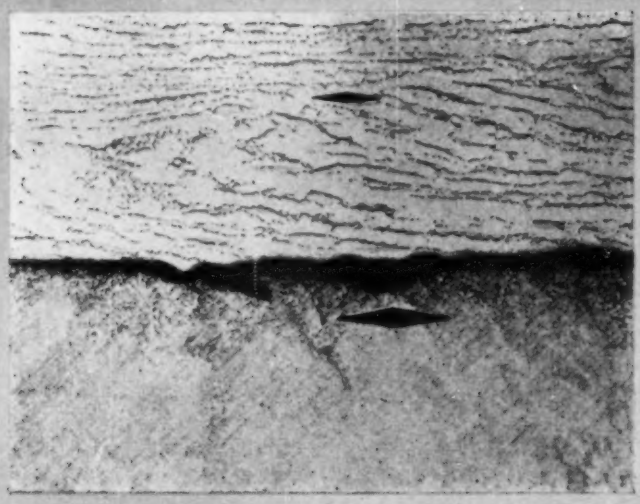

Fig. 3—Structure (250 X) of joint between 75A titanium and silver base brazing alloy A that shows hard intermediate alloy zone.

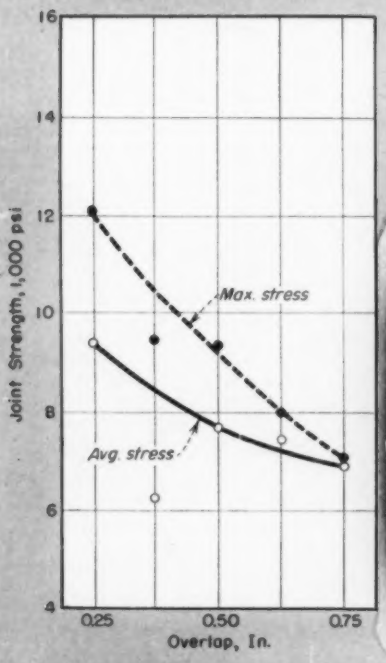

Fig. 4—Effect of overlap on joint strength of commercially pure titanium brazed with alloy A in a single lap joints pulled in tension.

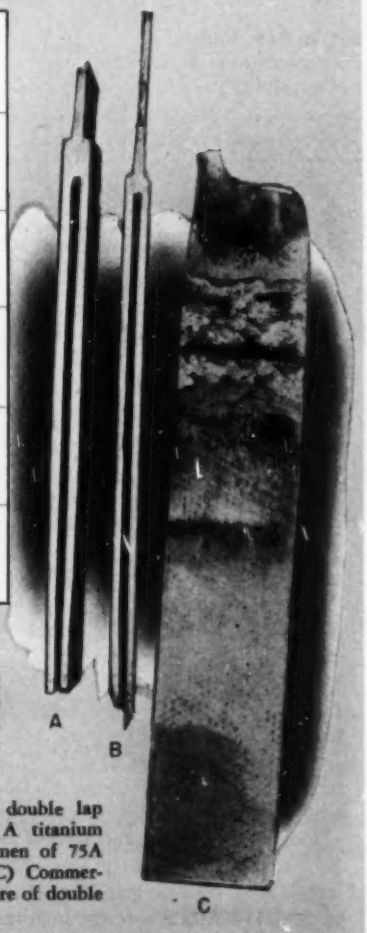

Fig. 5—Silver brazed titanium double lap joints.—(A) Specimen of 130 A titanium with ¼ in. overlap.—(B) Specimen of 75A titanium with ¼ in. overlap.—(C) Commercially pure titanium, typical failure of double lap joint pulled in tension.

specimens was obtained because of failure in the titanium sheet.

The results of the tension tests on single lap joints are so erratic that no reliable joint strength average can be selected. Because of the nature of the failures and the erratic strengths developed, the mechanisms of testing and stress behavior during loading become major factors in joint evaluation.

The manner in which the specimen joints failed indicated that a line of weakness was formed in brazing titanium with silver base brazing alloys. Abrupt failure with no noticeable yielding occurred. Examination revealed that the fracture usually propagated through the intermediate alloy zone and invariably resulted in rather varied strength results depending on several stress influencing factors.

In a microscopic examination of the specimens to determine the type of bond and the mechanism of failure, the presence of a boundary constituent believed to be rich in titanium was noted at the titanium silver alloy interface as shown in Fig. 3. After polishing, this specimen was etched with a 10 percent solution of NaCN. Tukon tester hardness measurements using a pyramidal diamond identer and a 200 gram load indicate that in the immediate area of the interface zone the hardnesses are: Titanium, 345 Knoop ($32R_c$); intermediate zone, 666 Knoop ($57.5\ R_c$); and silver solder, 147 Knoop ($77\ R_B$). The existence of this brittle interface is considered as adversely affecting joint strength since rupture occurs without yielding.

This interface is considered to be similar to those formed by all the silver base brazing alloys listed in Table I.

In aluminum brazed alloy joints, an intermediate alloy zone also exists between the titanium and the aluminum. This zone, however, appears to be much softer than titanium.

In wetting and flowing characteristics, aluminum and its alloys appear to have a definite advantage over silver base alloys. Joints prepared with aluminum alloys, however, are generally weaker.

In tests where the amount of overlap was varied, results indicated that as the overlap increased the unit joint strength decreased. The influence of amount of overlap in a single lap joint pulled in tension is shown in Fig. 4.

Table V—Joint Strengths for Double Lap Titanium Joints Brazed with Different Alloys

All specimens were torch brazed.

Material	Brazing Alloy	Overlap, in.	Joint Area sq. in.	Joint Load, lb	Joint Strength, psi
130 A Titanium	A	1/4	0.500	8,800	>17,600*
	C	1/4	0.500	8,940	>17,880*
	G	1/4	0.500	8,600	17,200**
	K	1/4	0.500	4,670	9,340**
75 A Titanium	A	1/8	0.250	6,310	>25,240*
	C	1/8	0.250	6,220	>24,880*
	G	1/8	0.250	6,080	>24,300*
	K	1/8	0.250	4,130	>16,520*

*Fracture in titanium.
**Incomplete joint.

Table VII—Strength of Rapidly Formed Titanium Brazed Single Lap Joints With Variation in Joint Thickness

All specimens were brazed with brazing alloy A using a split torch.
Joint area of all specimens was 0.125 square inch.

Specimen	Joint Thickness, in.	Joint Load, lb	Joint Strength, psi
1	0.002	2,790	22,300
2	0.002	2,500	20,000
3	0.003	3,520	28,200
4	0.003	2,420	19,300
5	0.006	3,200	25,600
6	0.006	2,600	20,800
7	0.010	3,230	25,800
8	0.010	3,170	25,400

Table VI—Joint Strength of Brazed Titanium Double Lap Joints Formed by Torch and Furnace Brazing

Joint area of all specimens was 0.25 square inch.

Brazing Alloy	Specimen	Joint Load, lb	Joint Strength, psi
Torch Brazed Joints			
G	1	5,540	22,160
	2	5,200	20,800
	3	5,900	23,840
	4	5,730	22,920
	5	5,320	21,280
A	1	9,230	>36,920*
	2	4,940	19,760
	3	4,540	18,160
	4	8,670	34,680
	5	6,880	27,520
B	1	6,750	27,000
	2	4,400	17,600
	3	4,600	18,400
	4	4,050	16,200
	5	5,760	23,040
K	1	5,480	21,920
	2	5,500	22,000
	3	3,700	14,800**
	4	5,080	20,320
	5	5,000	20,000
Furnace Brazed Joints			
G†	1	1,230	4,920
	2	5,080	20,320
	3	4,540	18,160
	4	2,850	11,400
	5	3,380	13,320
A‡	1	1,930	7,720
	2	5,650	22,600
	3	2,040	8,160
	4	1,930	7,720
	5	1,940	7,760

* Fracture in 130A titanium. ** Poorly formed joint.
† Furnace brazed at 1500 F. ‡ Furnace brazed at 1450 F.

The curves represent the maximum and the average fracture stresses for three specimens in each of five groups of specimens having overlaps of 0.25, 0.37, 0.50, 0.62, and 0.75 in. respectively.

The inability of the titanium to yield locally for load adjustment before joint failure, coupled with the relatively brittle interface phases, indicates that the ultimate joint strength of brazed titanium is design sensitive with particular reference to tensile stresses. It appears that the critical stress is developed in the end of the joint where notch effect is influential in promoting sudden failure.

Presumably greater joint strength could be developed if the material in the entire joint was ductile enough to permit more deformation at the ends of the joint, mainly for distributing the stress more uniformly.

To indicate the order of joint strength in pure shear, series of double lap joint specimens with $\frac{1}{8}$ in. and $\frac{1}{4}$ in. overlap were prepared. The $\frac{1}{8}$ in. overlap specimens, Fig. 5 (B), were 0.064 by 1 by 4 in. 75A titanium. The $\frac{1}{4}$ in. overlap specimens, Fig. 5 (A), were 0.064 by 1 by 4 in. 130 A titanium. In Table V are given the test results for these specimens as brazed with different alloys. The failure shown in Fig. 5 (C) is typical of those obtained in double lap joints pulled in tension.

The data obtained with the $\frac{1}{8}$ in. joints are probably more representative of the joint strengths for the material tested. In all specimens of this series, the faying surfaces were completely bonded with silver brazing alloy. In the $\frac{1}{4}$ in. joints, there was a tendency toward flux entrapment.

In a further study of joint evaluation, silver base brazing alloys A, B, and G, and the aluminum alloy K were selected for investigation. With these, double lap specimens were prepared using 0.064 by 1 by 3 in. RC 70 titanium overlapped $\frac{1}{8}$ in. on each side of a middle strip of 130 A titanium with its high tensile strength to insure failure in the joint.

In all specimens, the joint assembly was fluxed, clamped and brazed; the joint being formed by capillary action.

The specimens were brazed using an oxy-acetylene torch; with the silver base brazing alloys, titanium brazing flux No. 29 was employed; with the aluminum base alloy, flux No. 110 was employed.

Double lap specimens were also prepared by furnace brazing techniques using silver base alloys A and G and No. 29 flux.

Results of shear tests on these torch brazed and furnace brazed specimens are given in Table VI. While there are some inconsistencies in joint strengths, the differences are not as widespread as those for single lap joints prepared in the same manner with these alloys. In addition, unit joint strength test results for double lap specimens are approximately twice those given in Tables III and IV for single lap specimens.

Furnace brazed joints exhibit generally lower and more erratic strengths than the torch brazed specimens of the same alloy.

To determine the effect of rapid joint formation and thickness of joint on joint strength, a series of single

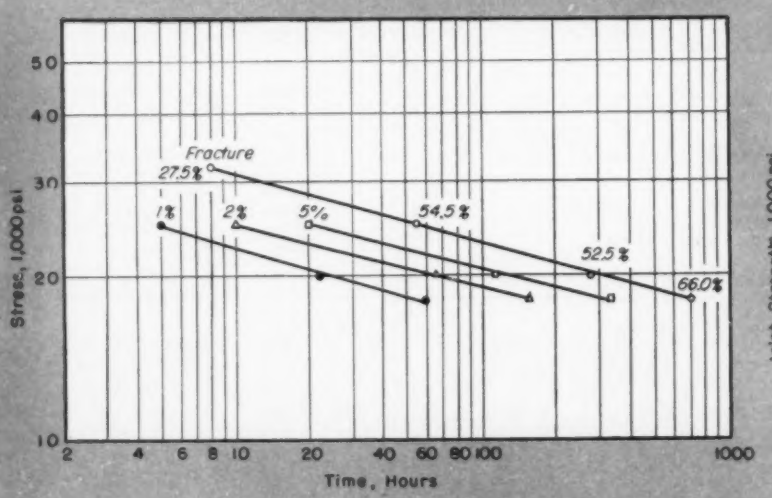

Fig. 6—Creep-rupture characteristics of commercially pure RC 70 titanium sheet at 800 F.

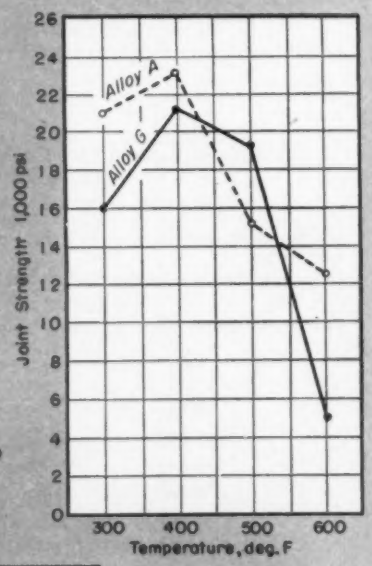

Fig. 8—Effect of temperature on short time joint strength of brazed titanium loaded at a rate of 4000 lb per minute. Joints of all specimens were double lap type.

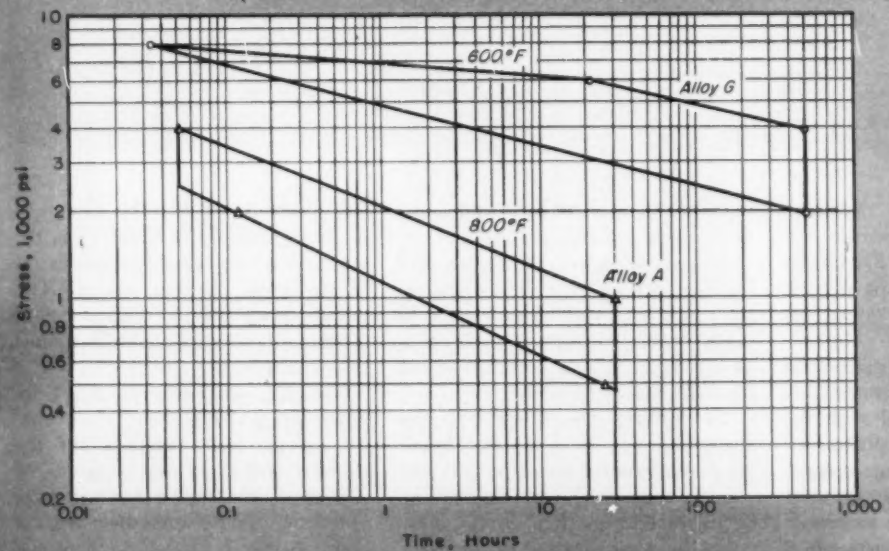

Fig. 7—Rupture characteristics of double lap joined RC 70 titanium torch brazed specimens.

lap joint specimens using brazing alloy A were prepared by a method described by Armour Research Foundation, Ref. 2. In this method, the joints are formed in a vertical clamping device that permits very rapid heating and control of thickness.

Using a split torch, heat concentration at the joint reduced brazing time from several minutes to about five seconds when preplacing both the brazing alloy and flux.

The test results on these rapidly formed joints are given in Table VII.

Since the joint thicknesses of the specimens prepared by the rapid heating method are in the same range as those of the single lap joints prepared in the initial phase of the investigation, it is reasonable to believe that any change in joint strength could be the result of the preparation method. Strength evaluation of joints formed by both methods shows that the rapidly heated formed joints are far superior and relatively consistent.

Creep data were obtained from a study of the elevated temperature properties of commercially pure RC 70 titanium sheet. This behavior is shown in Fig. 6 at a temperature level of 800 F with the expected time to creep 1, 2, and 5 percent and fracture.

Time range for fracture in these tests varied from eight hours at 32,000 psi to 706 hours at 18,000 psi. In considering stress-rupture at 100 hours at 800 F, Du Pont (Ref. 3) has indicated that a stress of 32,000 psi is required to produce rupture.

To compare stress-rupture relationships of brazed joints with the parent material, double lap joints of RC70 titanium torch brazed with alloys A and G were tested at 600 and 800 F. The data are given in Fig. 7 as a band for expected times to fracture at any particular stress.

Tests of short time elevated temperature properties of similarly brazed joints were also conducted. Brazed double lapped joints were prepared with RC70 titanium of 0.064 by 1 by 8 in. strips brazed with alloys A and G. These were tested in shear in a tensile testing machine at load application of 4,000 lb per minute. The results of these tests at the various temperatures are given in Fig. 8. These data show the trend of the effect of increasing temperature on the short time high temperature properties of silver brazed titanium joints.

While fatigue testing on joints is not considered to be of great value because of difficulties in interpreting the data, such tests may approximate service conditions. With this viewpoint, 0.064 by 1 by 3 in. single lap joints with $\frac{1}{8}$ in. overlap were brazed by the rapid heat method with alloys A and G to determine their behaviors to reversed bending and pull-pull stresses.

Pull-pull tests were conducted on a Krouse direct stress fatigue machine from zero to various desired maximum stresses in the joints.

Based on the maximum stress developed in the joint, the results of pull-pull and reversed bending tests are shown in the form of S-N curves in Figs. 9 and 10, respectively.

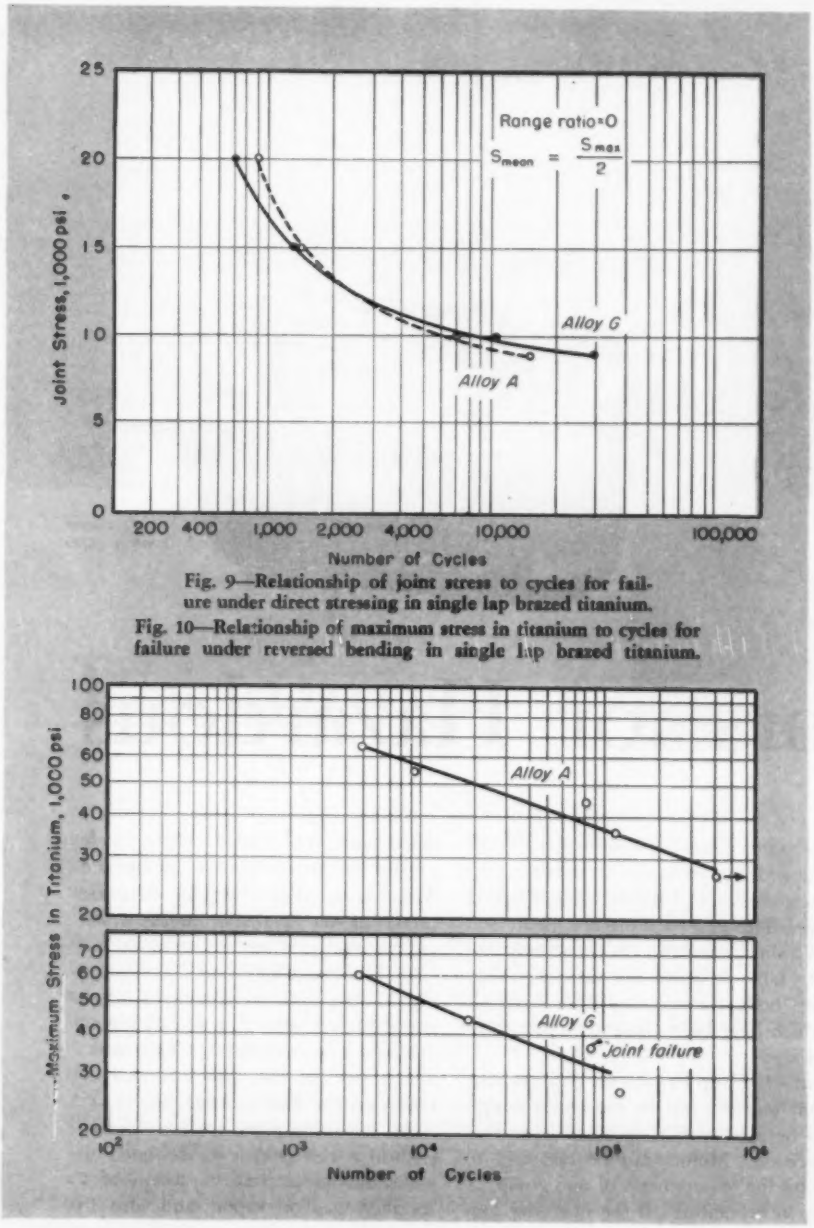

Fig. 9—Relationship of joint stress to cycles for failure under direct stressing in single lap brazed titanium.

Fig. 10—Relationship of maximum stress in titanium to cycles for failure under reversed bending in single lap brazed titanium.

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2. "Brazing and Soldering of Titanium and Its Alloys" by N. A. De Cecco, Armour Research Foundation, Report No. 10, ARF Project No. 90-1088B, June 19, 1952.

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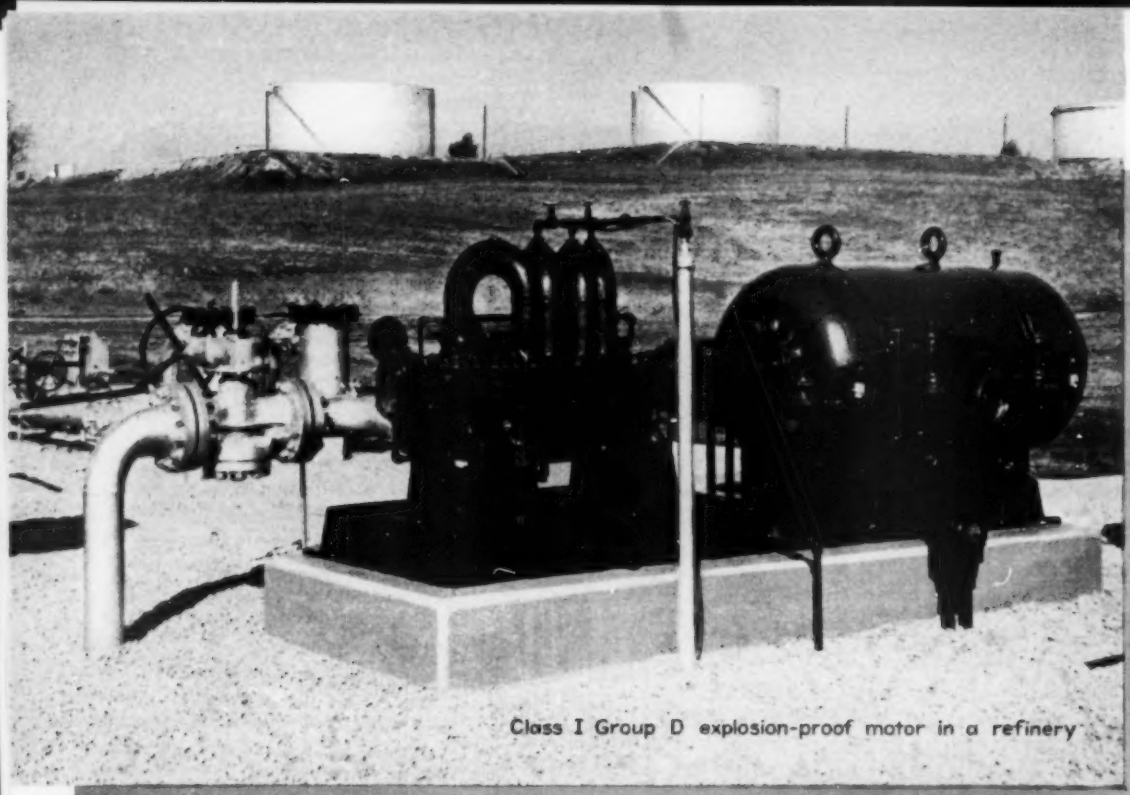
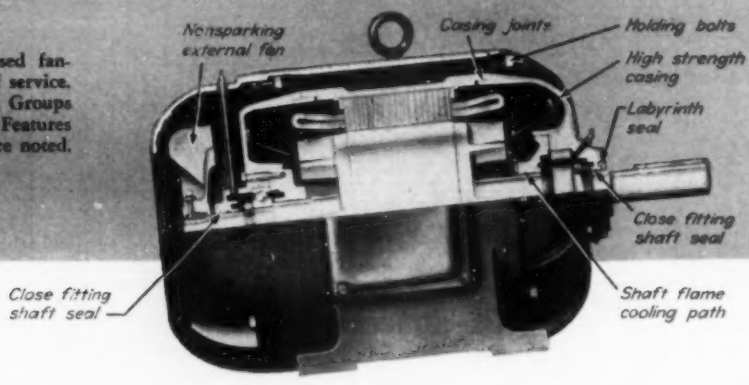


Class I Group D explosion-proof motor in a refinery

Fig. 1—Cut-away section of totally-enclosed fan-cooled induction motor for explosion-proof service. This design is suitable for use in Class II, Groups E, F, or G; or Class I, Group D locations. Features required for explosion-proof application are noted.



Motors for Hazardous

D. K. ADAMS
Motor & Generator Division
General Electric Co., Schenectady, N. Y.

ARTICLE 500 of the National Electrical Code defines two classes of hazardous locations: Class I hazards are those conditions that involve flammable gases or vapors, and Class II hazards are those that involve combustible dusts.

Since flammable gases and vapors vary widely in their explosive properties, particularly as to the rate of flame propagation and maximum explosion pressure, Class I locations are subdivided into groups in accordance with their explosive hazards. The Class II hazardous dust locations are subdivided in a similar manner. In the accompanying table is listed the various groups for both classes, and the materials which have been classified under these groups.

Each group has certain requirements that must be met by the motor design to be used in that specified hazardous location. Motors can be designed to meet the requirements of one group, or by incorporating all the necessary features, one motor design can be made suitable for more than one group and classification. For example, there are single motors available today which can be used in Class I Group D and Class II Groups E, F and G locations, Fig. 1. The hazards for which a motor is suitable are shown by a plate giving the class and group letter. This marking is part of the Label Service of Underwriters' Laboratories, Inc.

An explosion-proof machine has an enclosing case which is designed to withstand an internal explosion of a specified gas or vapor, and also to

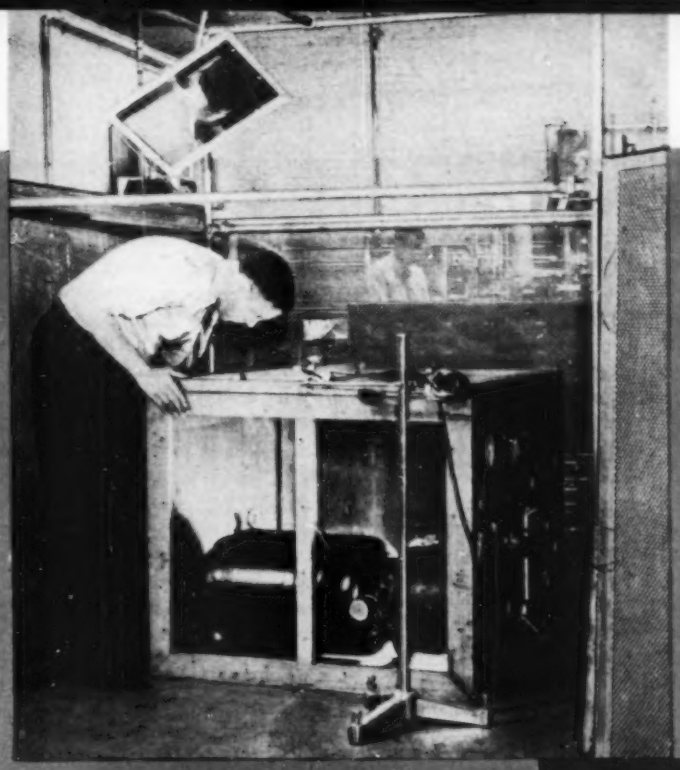
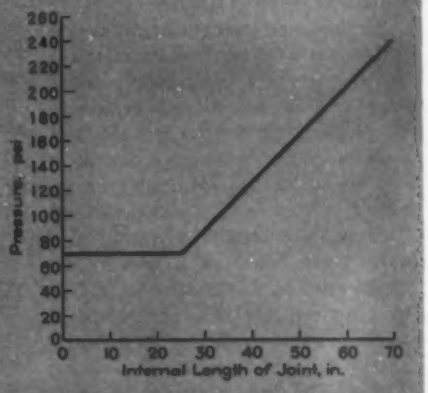


Fig. 3—Typical Underwriters' Laboratories set-up for testing explosion-proof motors in a hazardous-gas location. Percentage composition of gas-air mixture is varied to suit. Motor shown is Class I, Group D. Photo, Underwriters' Laboratories, Inc.

Fig. 2—Plot of internal explosion design pressure versus internal length of joint. Taken from Underwriters' Laboratories Standard, Subject 674 (B).



Locations

prevent the ignition of the specified gas or vapor surrounding the motor by sparks, flashes or an explosion within the machine casing.

A dust-explosion-proof machine has an enclosing case which is designed so as not to cause the ignition or explosion of an ambient atmosphere of the specific dust, and also to prevent the ignition or explosion of the dust on or around the machine.

Explosion-proof motors to meet Class I hazardous conditions must have high mechanical strength and flame cooling paths of sufficient length and small clearance so that sparks from an internal explosion cannot be transmitted to the surounding atmosphere.

On the other hand, dust-explosion-proof motors to meet Class II hazardous conditions do not need extra mechanical strength but must be sufficiently tight at all openings to keep out the specified dust. Successful operation of dust-explosion proof motors requires that there be no overheating from such causes as excessive overloads, stalling or accumulation of excessive quantities of dust on the machine.

Class I Motors

Motor designs for Class I Group D locations are most common. They have the following design features:

1). Casing strength giving calculated factor of safety of 5 for cast iron or 4 for fabricated steel over maximum explosion pressure.

2). Bolt strength giving calculated factor of safety of 3 over maximum explosion pressure.

3). Minimum 5 full threads—where threaded joints are used.

4). Long close fitting joints in cas-

ing capable of cooling flame below ignition point.

5). Seal around leads between frame and conduit box.

6). Explosion-proof conduit box.

7). External fans of nonsparking material.

8). No removable plugs.

The required strength of the casing determines a certain minimum thickness of parts to withstand the pressure developed by an internal explosion. The motors are not vapor tight, and therefore it can be assumed that there is a chance of an inflammable or explosive mixture being inside the motor. This mixture could be ignited by a spark from either an abnormal condition such as stator winding failure in a squirrel-cage induction motor or under normal conditions from brush sparks on the commutator of a d-c motor. The normal design pressures are shown in Fig. 2. The curve is plotted with the circumference of the fit between stator and end shield as an indication or measure of the internal free volume of the machine. This in turn establishes the design pressure for a test sample.

Every hazardous gas or vapor has a range of inflammability based on the percent by volume of gas in a gas and air mixture. Ignition will not occur above or below the limits of this range. However, the mixture which gives the maximum pressure may not be the same as the mixture which has greatest tendency to propagate flame through joints in the casing. Both of these values have been established by the Underwriters' Laboratories and sample motors are tested, Fig. 3, under both conditions.

The minimum size and number of bolts, and the maximum spacing between bolts are also determined by the maximum pressure. The spacing is important since internal pressure will tend to open up the normal clearance between joint surfaces permitting flame to escape outside the motor. Maximum spacings of 6 in. with the use of four or more bolts are recommended. Slightly larger spacings have been used when the parts have been proven by test to be rigid enough to prevent excessive clearance under explosion pressure. Typical of such parts are motor end shields and frames of cylindrical construction which inherently are more rigid than flat plates.

When threaded joints are used, such as between the conduit box and rigid conduit, a minimum of five threads must be engaged so that with standard clearance between threads the flame will be cooled sufficiently by the time it travels from inside to outside.

The length of casing joints is a function of the clearance between parts and whether there is a right angle turn in the flame path. For example, in a motor using a rabbet joint where the end shield fits the stator frame, a minimum total length of $\frac{3}{4}$ in. may be suitable if the maximum diametral clearance is not more than 0.004 in. and the plane fit clearance is not more than 0.002 in. However, the shaft opening, which requires greater clearance in normal operation, can have a clearance of 0.025 in. if the minimum length of flame arresting path of $1\frac{1}{2}$ in. is maintained along the shaft.

The shaft flame path seal is located on the inner side of the bearing on the integral horsepower motor shown in Fig. 1 so that the bearing can be lubricated. There is also a removable plug in the bearing housing for pressure relief during re-lubrication. The grease and relief fittings must be outside of that part of the motor which is designed to retain an internal explosion, since the fittings do not provide proper flame cooling paths and might permit transmission of an internal flame to the outside hazardous atmosphere.

Space restrictions often require that holes for mounting bolts be drilled in a flame arresting joint. Where visual inspection can readily determine that all bolts are in place, this construction is permitted with certain restrictions. The joint from the inside to the bolt hole must not be less than $\frac{1}{2}$ inch. Also, the length of path along the bolt and bolt hole must be at least one-half the total required length of the joint. The diametral clearance between bolt and drilled hole must not be greater than 1/32 in. In Fig. 4 is shown a typical joint of this kind.

Much higher pressures than shown in Fig. 2 will be obtained if the motor is divided into essentially two compartments with a restricted connecting passage. Ignition in one end causes pre-compression of the gas in the other end before its ignition by flame traveling through the connecting passage. Unless motors are made strong enough for the higher pressure, they must have the enclosed parts so disposed that there is either a free interchange between ends or the connecting passage is long enough to cool the flame, preventing ignition of the compressed gas in the opposite end. For the same reason, the leads are sealed with a non-shrinking material at the point where they emerge from the stator frame into the conduit box.

Totally-enclosed fan-cooled motors for Class I locations must have an external fan made of nonsparking material to prevent sparks which might otherwise occur either by the accidental insertion of foreign material or through the fan striking a metal part. Also, the fan material must be such that it will not cause a static spark.

Removable plugs must not be used in the enclosure of explosion-proof motors since frequently such plugs are removed during normal maintenance and not replaced.

Motor designs for Class I Group C (ether) locations have two special features that are required to meet the more severe conditions. These are in addition to the above design limitations for Group D conditions. A special labyrinth seal, Fig. 5, is used to lengthen the shaft flame path since the straight path of Class I Group D motors will not arrest flames of ether-air mixtures. These motors are also equipped with a thermostat to shut off the power supply when a temperature of 100 C is reached because the ignition temperature of an ethyl ether-air mixture is only slightly above normal motor operating temperatures.

At the present time there are no suitable motor designs for Class I Group A and B locations.

Class II Motors

Motors for Class II hazardous locations do not require extra strength parts to withstand high pressure, since the basis of design is to prevent dust from entering into the motor enclosure. Therefore, these motors need only be strong enough to withstand normal usage, and are comparable to standard nonexplosion-proof designs in enclosure strength.

The most common motor applications in Class II locations are those involving grain or similar dusts covered by the Group G classification.

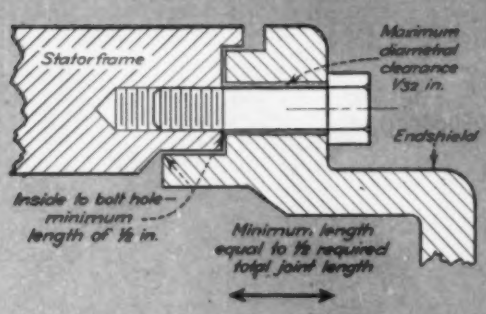
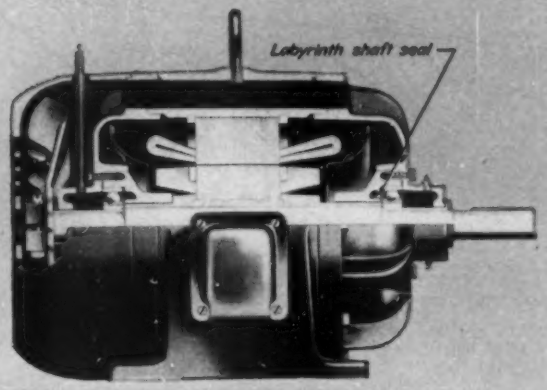

Stator frame
Maximum diametral clearance 1/32 in.
Endshield
Inside to bolt hole—minimum length of 1/8 in.
Minimum length equal to 1/2 required total joint length

Fig. 4—Limitations of bolt hole and joint when hole is part of the flame path arresting joint.

Fig. 5—Explosion-proof motor for Class I, Group C hazardous locations. Note long axial shaft seal and addition of labyrinth seal to increase length of flame path for these conditions.



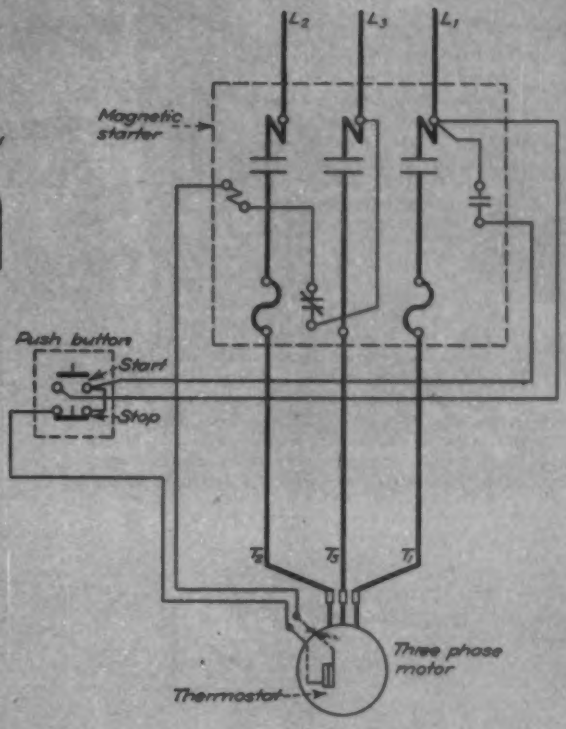


Fig. 6—Control circuit wiring diagram for three-phase explosion-proof motor. Thermostat, in stop button circuit, is used to shut off power when fault condition in the internal stator or rotor windings might cause motor casing temperature to exceed the ignition point of surrounding mixtures.

The design of motors suitable for this condition involves joints which are tight enough to prevent the entrance of the particular dust, Fig. 1. The shaft openings differ from those of motors that are designed exclusively for Class I locations. For dust-explosion-proof motors, the shaft seal is between the outside and the bearing. Dust in the bearings could cause overheating and burning of the dust.

The permissible operating temperature of motors used in the Class II Group G location is lower than for other dusts since grain dust chars at approximately 165 Centigrade.

Motors for Class II Group F coal or coke dust locations are similar to those for Group G. Coal dust does not have as restrictive a temperature limitation since dusts in this classification do not char until the temperature reaches approximately 400 C.

Metal dusts, such as magnesium dust of Class II Group E locations are extremely fine and require special precautions at the openings to prevent their entrance into the motor enclosure. A labyrinth seal is used at the drive end since the straight flame paths along the shaft, which are typical of Groups F and G, have been found inadequate.

Temperature Limitations

Equipment used in hazardous locations must be designed so that even under abnormal conditions the apparatus will not reach a surface temperature that will ignite the surrounding gas or dust atmosphere.

Burnout tests are made on these motors to determine the maximum surface temperature under the worst conditions. This test is made under the assumption that full voltage is maintained while the motor is stalled and that the overload failed to function.

Power is applied until the circuit is broken by burning open the motor winding. Temperatures of the motor surfaces are recorded until the maximum is established. Recent tests show that motors using Class H insulation may conceivably reach temperatures above the ignition point of gasoline-air mixtures before burning open. Therefore, thermostats are needed in the motor to open the power circuit. These auxiliary safety devices, Fig. 6, are similar to those used on Class I Group C motors but with different operating temperatures.

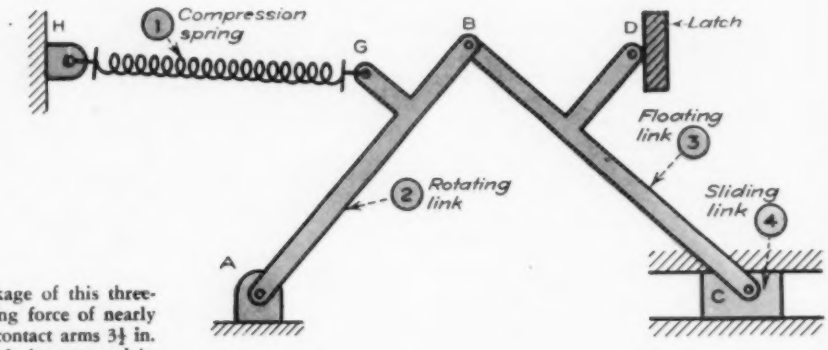
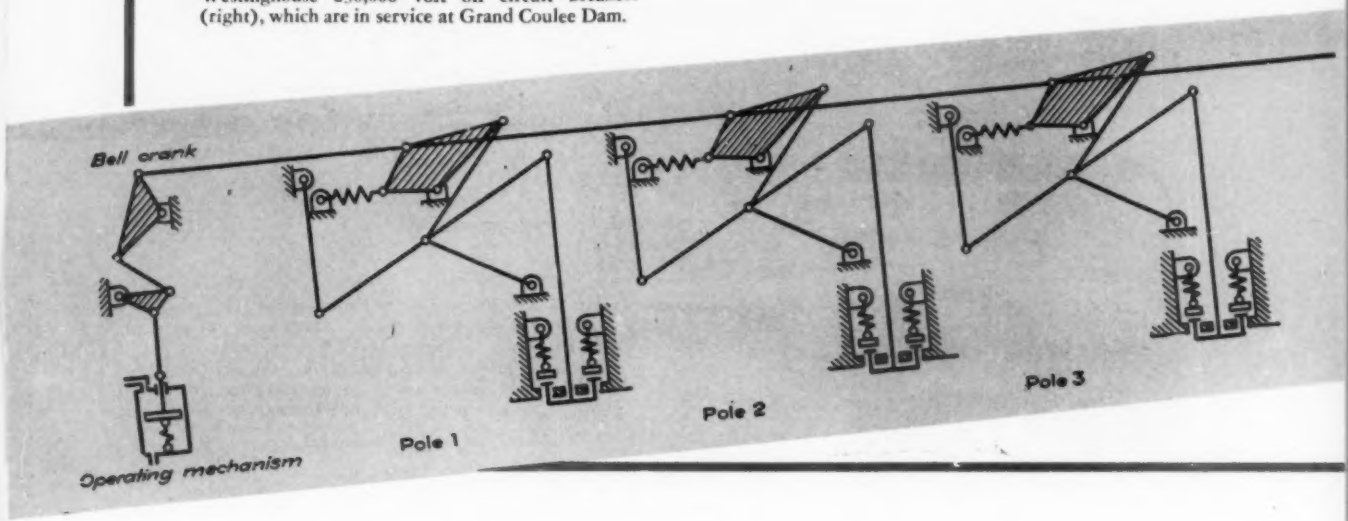


Fig. 2 (Right)—Simple spring actuated linkage in which the directions of all forces and link motions lie in a vertical plane, in it are all the elements normally found in spring actuated linkages. Point C on the slider is chosen as the reference point.

Fig. 1 (Below)—Mechanical linkage of this three-phase circuit breaker uses a spring force of nearly two tons per phase to move the contact arms 3½ in. in less than 1/20 second. The analysis presented in this article was experimentally verified on the Westinghouse 230,000 volt oil circuit breakers (right), which are in service at Grand Coulee Dam.



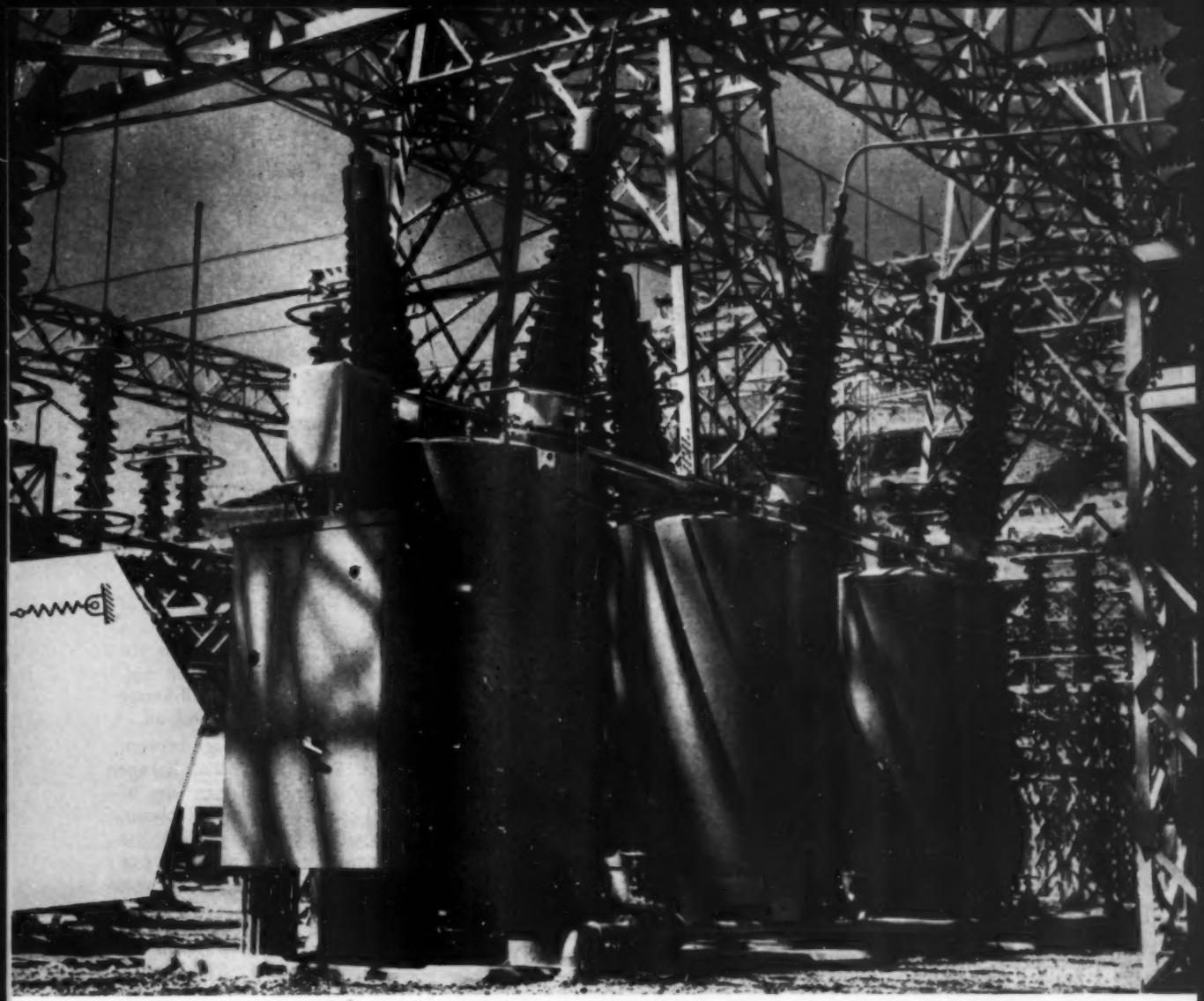
Spring Actuated Linkage

R. C. VAN SICKLE
THOMAS P. GOODMAN
Switchgear Division,
Westinghouse Electric Corporation

IN REVISING THE DESIGN of high speed spring actuated linkages to obtain an increase in speed of operation, the problem is more complicated than first appears. For example, when a spring sets a linkage in motion, it would appear at first that to increase the speed it would be only necessary to increase the spring force.

An increase in spring force, however, will increase the mass of the spring. Also, to prevent the larger spring force from overstressing the links, an increase in their cross sections may be necessary. Any increase in the inertia of the links may decrease the speed of operation. Thus the increase in spring force may possibly result in slower, rather than faster, operation.

The satisfactory redesign of a high speed linkage, therefore, must be based on careful calculation of inertias and strengths as well as accelerating forces. In principle, the method of calculation that will be described is applicable to any mechanical linkage, large or small. It is particularly applicable, however, when the system consists of several parts that have different relative motions at different parts of the travel and that cannot be reduced to a simple member of constant mass acted upon by a single force. This method reduces the system to a variable mass at a selected reference point and de-



Analysis to Increase Speed

termines the speed of the point from the energy that has been released in the system and that must appear as kinetic energy.

This method was verified experimentally by timing tests on a large mechanical linkage actuated by a spring force of nearly six tons. This operating linkage is employed in the Westinghouse 230,000 volt oil circuit breakers in service at Grand Coulee Dam, Fig. 1. This linkage consists of 23 springs, 12 rotating links, 7 floating links, and 14 sliding links.

Friction, inertia, spring force, and mechanical advantage are the most important factors affecting the speed.

Reduction of friction at pivots can result in a considerable increase in the mechanical efficiency of the linkage. In a circuit-breaker linkage where motion occurs infrequently and only for a part of a revolution, the starting friction of the bearing is much more important than the running friction. Anti-friction bearings, therefore, may be advantageous.

Inertia of links can be reduced by using materials of lighter weight or by reducing the dimensions of their cross sections. The higher the velocity of a link, the greater is the gain in speed obtained by reducing its inertia. When a rotating link has a large moment arm, the portion near the center of rotation has little effect on the inertia. The portions that are distant from the center of rotation, however, have a large effect on the inertia, hence their mass should be kept to a minimum.

The mechanical advantage, or veloc-

ity ratio of the linkage between a given point and the reference point affects the speed because as will be shown later, the equivalent mass is proportional to the square of the mechanical advantage.

For a given force at the reference point, the force on a link—such as a pull rod—varies inversely as the mechanical advantage, while the strength of a rod of a given material varies directly with rod cross-section and hence directly with weight. Thus if the mechanical advantage is halved, the force that must be transmitted is doubled, and the weight of the link must be approximately doubled to carry the load; but the equivalent mass becomes ½ of its former value. Thus an increase in speed can be obtained by reducing the mechanical advantage. The loads cannot be increased indefinitely, however, as the difficulty of keeping the centers at fixed, or nearly fixed, distances increases as the loads increase, and the effect of temperature differences on the lengths of the respective links becomes a limiting factor.

Calculations of the speed of operation disclose the relative importance of the elements that determine the speed and thus suggest design modifications for increasing the speed. From a series of calculations, it can be decided whether the speed of a linkage can be increased by minor design changes, or whether an entirely new design is necessary.

Calculation of Speed

To demonstrate the method of calculation, consider the simple linkage shown in Fig. 2, in which the directions of all forces and link motions lie in a vertical plane. The linkage shown contains all the types of elements normally found in spring actuated linkages; namely: Spring; rotating link; floating link; and sliding link. The spring force acting at point G in the direction H to G is transmitted through the links to impose a force at point C in a horizontal direction.

With the system latched, the energy in the system is entirely potential. The energy available to start the links in motion is that which, neglecting friction, was required to compress the spring and to lift the rotating and the floating links from their former positions in the free extended unlatched linkage.

After the latch is tripped and the linkage is in motion, if friction is neglected no energy is added to or subtracted from the system. At any operating position, the sum of the potential energies and the kinetic energies of the several elements in the linkage is equal to the potential energy that was stored in the latched system.

By calculating how much potential energy remains in the system at a given position of the linkage, the amount of potential energy that has been converted to kinetic energy can be determined. Then the velocity of any point in the linkage at the given position can be found by equating the work done on the system up to the given position to the kinetic energy in the system at that position. In the calculations, friction is neglected at first; corrections for friction losses are applied later.

As the linkage is displaced, the force exerted by the spring changes in direction and magnitude, the moment of inertia of the floating link varies with its position, and the relative velocities of the several links also change with position. It is advantageous, therefore, to select one point on the linkage as a reference point and then calculate equivalent forces, equivalent masses, and equivalent velocities of the several parts of the system as referred to the reference point.

In the linkage shown in Fig. 2, the point C on the slider is selected for the reference point.

Where

F_C = force output at C in the horizontal direction, lb

F_G = force input at G in the direction H to G, lb

ΔS_C = small distance moved by C in the horizontal direction, ft

ΔS_G = small distance moved by G in the direction H to G while C moves through ΔS_C, ft

V_C = velocity of C in the horizontal direction, ft per sec

V_G = velocity of G in the direction H to G while C has the velocity V_C, ft per sec

Q = mechanical advantage, that is, ratio of force output to force input neglecting friction, ratio of distance moved through by point of input to that of point of output, or ratio of velocity of point of input to that of point of output.

Then for small displacements of the linkage, the mechanical advantage of the linkage between G and C is

$$Q = \frac{F_C}{F_G} = \frac{\Delta S_G}{\Delta S_C} = \frac{V_G}{V_C}$$

Since point H is fixed on the frame and point G is constrained to move in a circular arc about the pivot point A, it is evident that the direction H to G changes as the linkage is displaced. Also, the ratio of increments of change in the distance S_G, or changes in the velocity V_G, to uniform increments of change in the distance S_C, or changes in the velocity V_C, respectively, is not constant. The mechanical advantage of the linkage between G and C, therefore, varies with the position of the links.

Thus the equivalent force F_G' of the spring referred to point C for a given position of the links is the spring force F_G at that position multiplied by the mechanical advantage between G and C at that position.

The mechanical advantage between G and C during a cycle of linkage operation can be found by any of the well-known methods for obtaining the ratio of V_G to V_C. A less accurate method is to plot values of ΔS_G and ΔS_C obtained by measurement from a graphical scaled layout showing the links at a successive sequence of small displacements of the linkage. The values of the ratios of $\Delta S_G/\Delta S_C$ -thus obtained, of course, are equivalent to those of V_G/V_C for the respective displacements.

Similarly, for any position of the unlatched linkage, the mechanical advantage between the weight W_2 of the rotating link, or the weight W_3 of the floating link, and the horizontal force imposed by the respective weight through the linkage on point C is the ratio of the vertical velocity, or the vertical increment of displacement, of the center of gravity of the link to the velocity, or increment of displacement, of C in a horizontal direction.

Thus the equivalent force of the weight of each link referred to point C is the weight of the link multiplied by the mechanical advantage between the center of gravity of the link and point C on the slider.

The equivalent mass referred to point C of any link is the mass at point C that would have the same kinetic energy as the mass of the link.

Where

M_1 = mass of the spring, lb/32.2
M_2 = mass of rotating link, lb/32.2
M_3 = mass of floating link, lb/32.2
M_4 = mass of sliding link, lb/32.2
M_1' = equivalent mass of spring referred to point C, lb/32.2
M_2' = equivalent mass of rotating link referred to point C, lb/32.2
M_3' = equivalent mass of floating link referred to point C, lb/32.2
I_2 = moment of inertia of the rotating link about its center of rotation A, lb ft²/32.2
I_3 = moment of inertia of the floating link about its instantaneous center of rotation, lb ft²/32.2
k_2 = radius of gyration of the rotating link about point A, ft
k_3 = radius of gyration of the floating link about its instantaneous center of rotation, ft
ω_2 = angular velocity of the rotating link about point A, radians per sec
ω_3 = angular vlocity of the floating link about its instantaneous center of rotation, radians per sec
$V_2 = k_2\omega_2$ = velocity of point at the radius of gyration of the rotating link, ft per sec
$V_3 = k_3\omega_3$ = velocity of point at the radius of gyration of the floating link, ft per sec

then since one end of the spring is stationary and the other end has a velocity V_G, and neglecting the small amount of rotation of the spring a about point H, as it extends, the kinetic energy K_1 of the spring is

$$K_1 = M_1 V_G^2/6 = M_1' V_C^2/2$$

hence the equivalent mass M_1' of the spring referred to the reference point C is

$$M_1' = M_1 (V_G/V_C)^2/3$$

The kinetic energy K_2 of the rotating link is

$$K_2 = I_2\omega_2^2/2 = M_2 k_2^2\omega_2^2/2 = M_2V_2^2/2 = M_2'V_C^2/2$$

and the equivalent mass M_2' of the rotating link referred to the reference point C is

$$M_2' = M_2(V_2/V_C)^2$$

The kinetic energy K_3 of the floating link is

$$K_3 = I_3\omega_3^2/2 = M_3 k_3^2\omega_3^2/2 = M_3V_3^2/2 = M_3'V_C^2/2$$

and the equivalent mass M_3' of the floating link referred to the reference point C is

$$M_3' = M_3(V_3/V_C)^2$$

The kinetic energy K_4 of the sliding link, of course, is

$$K_4 = M_4V_C^2/2$$

Note that the force applied at any point in the linkage system is multiplied by the first power of the mechanical advantage to obtain the equivalent of that force as referred to the reference point. Also, that the mass of any link or part is multiplied by the square of the mechanical advantage to obtain the equivalent mass of that mass as referred to the reference point.

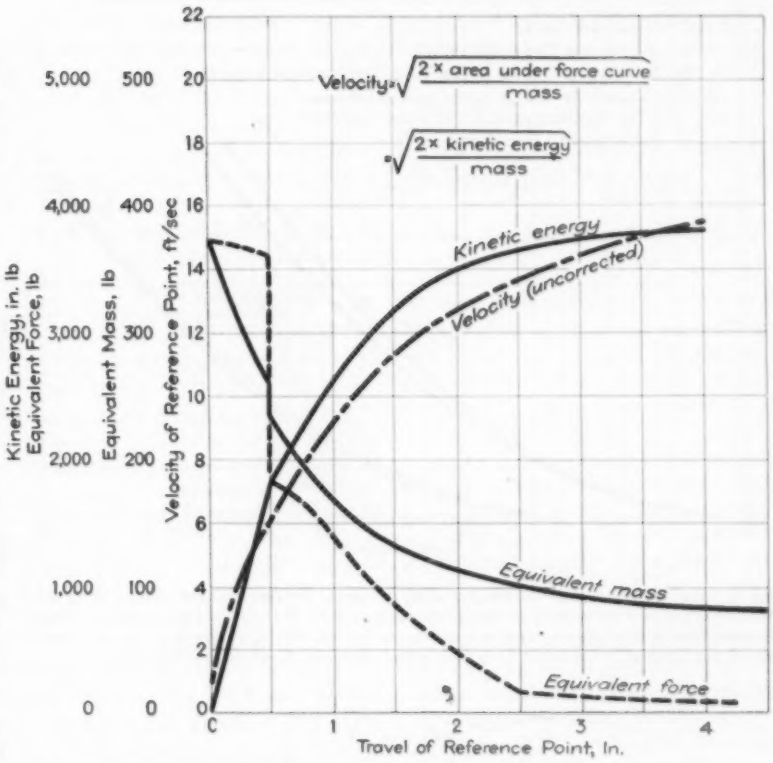


Fig. 3—Curves for calculating speed of operation. The curves shown are for circuit breaker installed at Grand Coulee Dam. Contact arm is taken as the reference point.

After finding the equivalent force for each force and the equivalent mass for each mass at a series of positions of the linkage, the next step is to plot curves of total equivalent force F' and total equivalent mass M' against travel of the reference point from the beginning to the end of its stroke. In Fig. 3 such curves are plotted for the circuit breaker installed at Grand Coulee Dam. In Fig. 3 the contact arm is taken as the reference point.

From these curves of total equivalent force F' and total equivalent mass M', a curve of velocity (uncorrected for friction losses) versus travel of the reference point C is next obtained by arithmetical summation, taking small increments of travel.

For a given travel from zero to S of the reference point, the loss of potential energy of the linkage system equals the work done by the system,

$$M' V_C^2/2 = \Sigma_0^S F' \cdot \Delta S$$

$$V_C = \sqrt{(2/M')\,\Sigma_0^S F' \cdot \Delta S}$$

For a given travel S, the value of term $\Sigma_0 F'.\Delta S$ is the area under the equivalent force-travel curve.

A curve of travel S versus time T is next obtained by arithmetical summation of the equation

$$T = \Sigma_0^S \Delta T = \Sigma_0^S \Delta S/V_C$$

Since at the beginning of the stroke the value of $\Delta S/V_C$ is infinite at S equal to zero, small increments of S must be used at the beginning to get accurate results. For the first small increment of travel at the start of motion, the difficulty of evaluating the summation can be avoided by using the relation

$$S = (1/2)\,(F'/M')\,T^2$$

$$\text{or } T = \sqrt{2\,M'S/F'}$$

Curve A in Fig. 4 is an uncorrected travel versus time curve obtained in this manner.

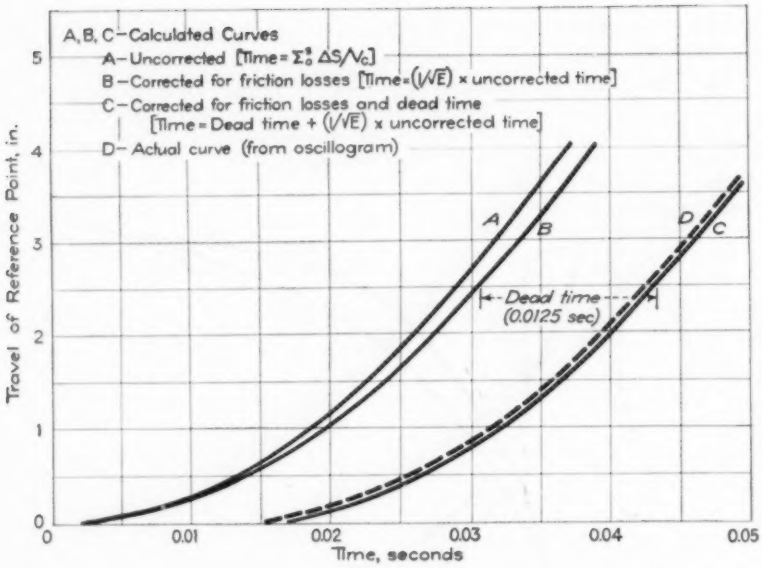


Fig. 4—Travel time curves for contact arms in circuit breaker linkage. Curve A is the uncorrected travel of contact arms versus time. Curve B is travel-time curve A when corrected for a mechanical efficiency of 90 percent. Curve C is travel of contact arms versus correct time. Curve D is actual travel obtained from an oscillogram.

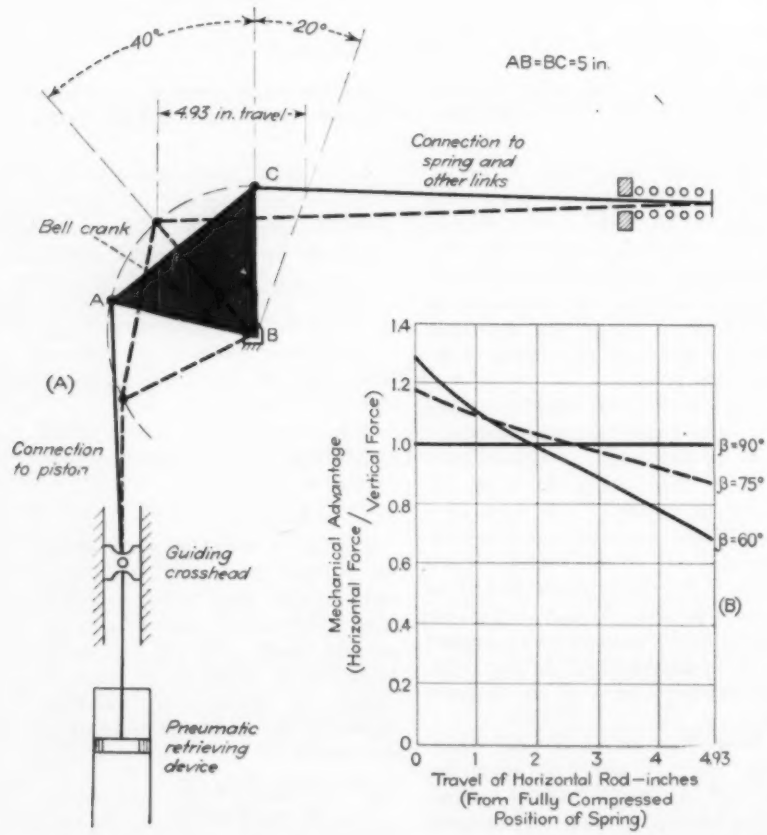


Fig. 5—(A) Bell crank linkage for retrieving device of spring actuated linkage. (B) Mechanical advantage of retrieving device for bell crank angles of 90, 75, and 60 degrees. In plotting these curves, the lateral motions of the rods were neglected.

Velocity and Time Corrections

As a result of friction losses, the potential energy is not converted to kinetic energy with 100 percent efficiency in an actual linkage. Where

K = kinetic energy in actual linkage
E = mechanical efficiency of the linkage, percent

$K = E \times$ (loss of potential energy)

Thus to correct for friction losses, the uncorrected velocity must be multiplied by $\sqrt{E}$, and the uncorrected time must be multiplied by $1/\sqrt{E}$. For the circuit breaker linkage tested, which had roller bearings, E was found to be 90 percent; curve B of Fig. 4 is the travel-time curve corrected for a mechanical efficiency of 90 percent. In previous designs using bronze bushings, E was found to be about 75 percent.

Another correction that must be applied to the time curve is the correction for "dead time" T_D between the unlatching signal and the start of motion. For the circuit breaker, T_D was found to be about 0.0125 sec. Of this amount, about 0.010 sec was an electrical time delay in the magnetic unlatching device, while the remaining 0.0025 sec was a mechanical time delay caused by a small amount of lost motion and the elasticity of the links.

When the latch is released and the floating link starts to move, the tension in the links is relaxed, so that there is a small movement in the floating link without a corresponding motion of the other end of the linkage. Consequently there is a small delay in the start of motion of the other links. On some oscillographic records, a slight oscillation can be noticed between the ends of the linkage.

The corrected time T' for a given travel is given by

$$T' = T_D + T/\sqrt{E}$$

Curve C of Fig. 4 is the curve of travel versus corrected time; curve D is the actual travel obtained from an oscillogram.

The method of originally finding the mechanical efficiency E and the dead time T_D is to calculate an uncorrected travel versus time curve for an existing linkage and compare this curve with an actual travel curve obtained from an oscillogram or by other

means. Values of E and T_D are then selected to make the calculated curve coincide as nearly as possible with the actual curve.

These values of E and T_D can be used for any similar linkage and should be valid for modifications of the existing linkage. Circuit-breaker timing tests have amply confirmed this assumption.

In speed calculations for a new linkage, where no suitable data exist, E can be estimated on the basis of the types of bearings to be used, and T_D can be estimated by adding together reasonable allowances for all the time delays in the system, including an allowance for lost motion and the elasticity of the links.

For certain special linkages, it may be necessary to assign a variable value to E, but for the linkages tested it was found satisfactory to take E as constant throughout the operating stroke.

The spring force may be increased to make more potential energy available for accelerating the parts. Such a procedure, however, will usually require that some of the parts be made heavier to avoid excessive stresses. This increase in inertia will at least partially offset the advantage that might be gained from the use of a greater spring force.

Retrieving Device

In addition to the speed and design considerations set forth in the foregoing discussion, the effect of increase of spring force on the design of the retrieving device for returning the links to their starting positions should be studied. Since the springs must be recompressed to retrieve the links, an increase in spring force may require a complete redesign of the retrieving device to obtain a greater compressing force.

The additional force can sometimes be obtained by increasing the mechanical advantage between the retrieving device and the spring to be compressed. A bell crank arrangement for obtaining such mechanical advantage, which is used on many Westinghouse circuit breakers, is shown in Fig. 5(A) in schematic form.

The lower end of the vertical rod of the retrieving device assembly is connected to the crosshead of a piston rod that is actuated by pneumatic pressure in a cylinder. The upper end of the vertical rod is attached to a bell crank. The horizontal connecting rod transmits the motion of the bell crank to the circuit breaker spring and to other links of the mechanism.

In this arrangement, compressed air acting on the piston exerts a substantially constant retrieving force, which is transmitted to the spring through the rod and bell-crank system shown. As the spring is compressed, its force builds up from zero to a maximum.

When the bell-crank angle β is 90 deg, the mechanical advantage for all positions of the linkage is 1 to 1, as shown in Fig. 5(B), and the maximum possible spring force is equal to the piston force. When β is less than 90 deg, at the compressed position of the spring, the mechanical advantage of the linkage between the piston and the spring is greater than 1 to 1, thus permitting the use of a maximum spring force that is greater than the piston force.

The mechanical advantage of the linkage between piston and spring for different distances of travel of the horizontal rod are plotted in Fig. 5(B) for bell-crank angles of 75 and 60 deg. These curves are based on the assumption that the bell crank operates through an angle of 60 deg and the lengths of the rods are such that their lateral motion can be neglected. The maximum spring force is 1.18 and 1.29 times the piston force for bell-crank angles of 75 and 60 deg, respectively. Thus the bell crank with an included angle of less than 90 deg permits the energy of the compressed air to be used more effectively in compressing the spring than does the 90 deg bell crank.

When the mechanical advantage and spring force are increased, however, the losses may offset the gains, since the equivalent masses of the vertical rod and piston increase with the square of the mechanical advantage, while the maximum spring force increases only with the first power of the mechanical advantage.

For this simple device, as well as for more complicated ones, there is a point of diminishing returns, up to which the speed of the linkage can be increased by increasing the spring force and mechanical advantage, but above which the speed cannot be increased by these means.

Because of the many variables entering the problem, the exact point of diminishing returns cannot readily be determined. Speed calculations when carried through for a series of modifications of the original linkage, however, will give a general indication as to whether the point of diminishing returns has been reached or whether a new linkage must be designed.

Summary

The steps in a program to increase the speed of an existing spring actuated linkage are:

1. Select one point on the linkage as a reference point. Calculations are simplified if this point is one that moves in a straight line.

2. Make a graph of the actual travel of the reference point versus time using an oscillograph or other means.

3. Calculate an uncorrected curve of travel versus time by the method outlined in this article.

4. Find values for the factors E and T_D that will make the calculated curve, obtained in Step 3, correspond as closely as possible with the actual curve obtained in Step 2. These values of E and T_D can then be used for the speed calculations for modifications of the existing linkage.

5. Reduce friction in the mechanism if practicable. If friction can be reduced, the improvement in the factor E must be estimated, and the improvement in speed calculated from this estimate.

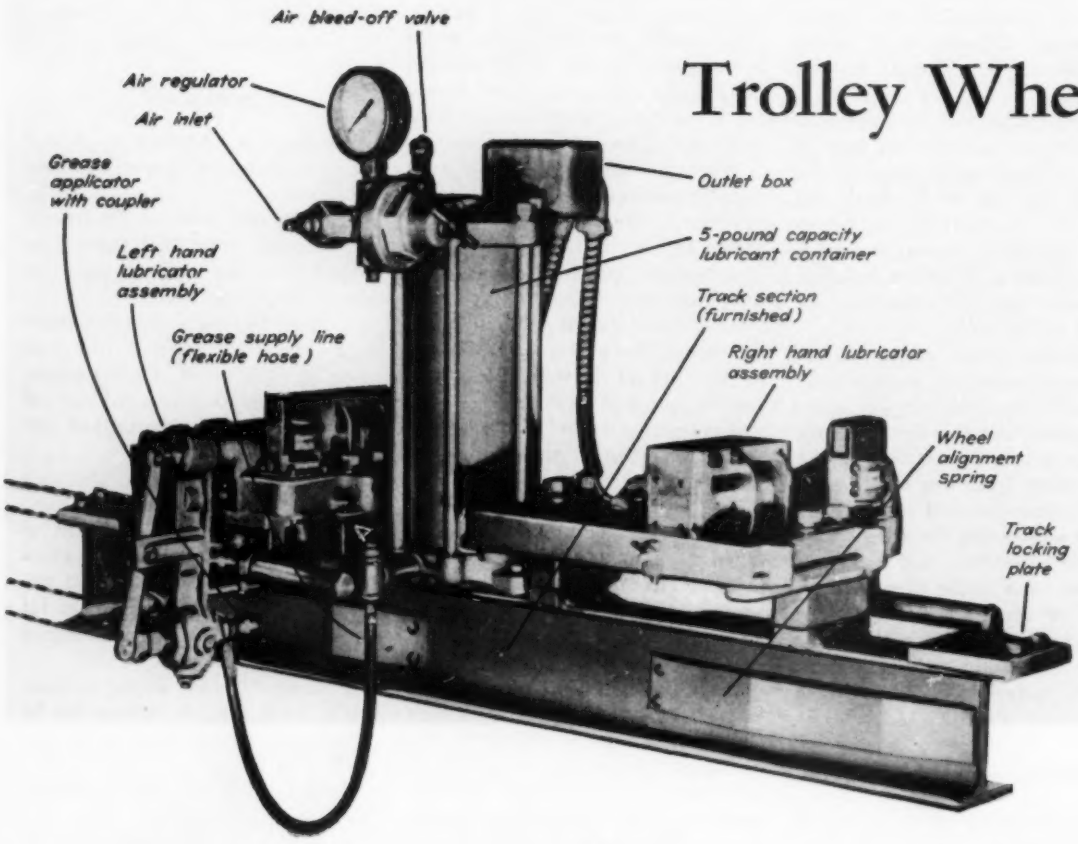
6. Reduce the equivalent masses of the links as referred to the reference point if practicable, especially those that have a high mechanical advantage. The equivalent mass can be reduced by the use of materials that have a higher strength-to-weight ratio, and by reducing the velocity ratio between the point at the radius of gyration of a link and the reference point.

7. Increase the spring forces and mechanical advantages if it can be done without increasing the retrieving force. In general, however, a point will be reached beyond which speed cannot be increased by these means.

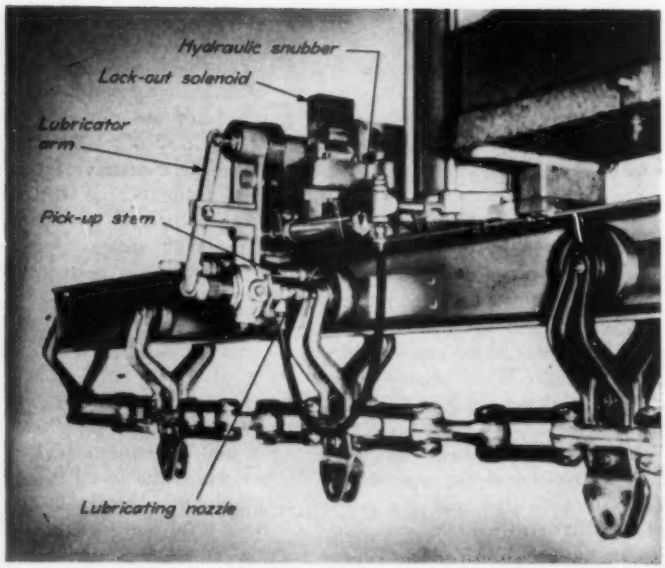
8. If the modifications suggested in the preceding steps are still not sufficient, as shown by speed calculations, to achieve the desired increase in speed, consider either redesigning the retrieving device to obtain a greater retrieving force, or redesigning the entire linkage so that some parts are disconnected in the operating stroke.

DESIGN FEATURES

Trolley Wheel



MAIN COMPONENTS OF LUBRICATOR. All components including lubricant container fit on top of the rails out of the way of conveyor travel. A special segment of track, with springs to help align the trolley wheels during greasing, are part of the equipment. The lubricator is designed as a packaged unit, complete with a section of track for installation in any existing overhead conveyor system.



LUBRICATOR delivers an exact amount of grease to the wheel bearings, without stopping the conveyor. The unit is protected from plant dirt by a sheet metal cover, not shown. The lubricator can be set for a desired number of operations and when finished, can be shut-off to allow normal passage of lubricated wheels. Two solenoids control the operation, one when unit is running and the other for no lubrication.

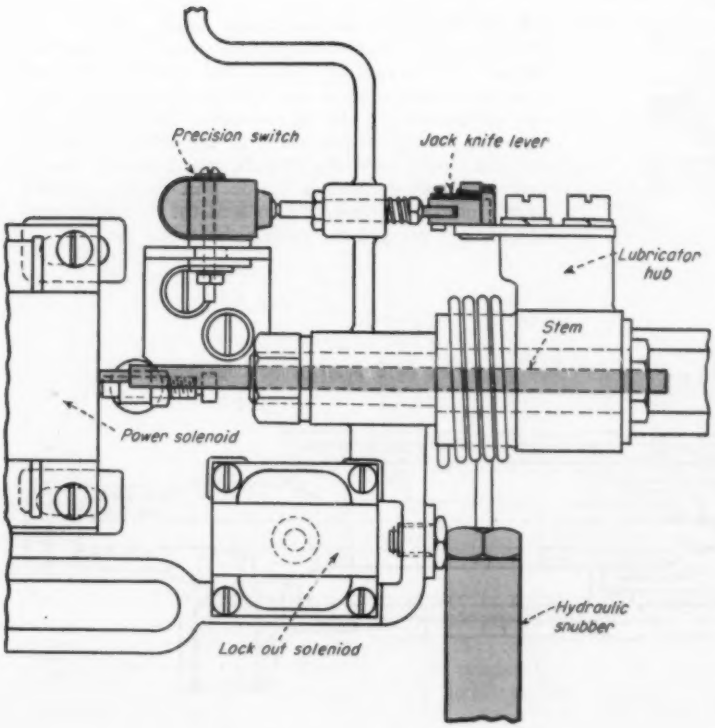
Controls Automatic Lubricator

The basis of a lubricator for automatically greasing trolley wheels of overhead conveyor systems, while the conveyor is in motion, is the contact of a pick-up arm, controlling the lubricator mechanism, by the moving trolley wheels.

The wheel controls the start of the lubrication cycle by moving the pick-up arm angularly to engage a jack knife lever actuating a precision switch. Actuation of the switch causes the power solenoid to force the pivoted lubricator arm forward. This movement forces the lubricator nozzle onto the wheel fitting, locating the nozzle accurately before starting the lubrication cycle. Passage of the pick-up arm over the wheel ends the greasing action and permits the lubricator arm to return to the normal pick-up position, ready to contact next wheel.

The lubricator unit, developed by the Alemite Division of Stewart-Warner Corp., is self-regulating and self-timed to trolley wheel speed. A quantity of lubricant, adjustable up to 0.005 cu in. per application, is forced into the fitting at a pressure between 800 to 1,000 psi. Wheels spaced as close as 8 in. between centers and moving at speeds up to 75 ft per min can be handled by the lubricator.

The lubricator is air operated when using heavy viscous lubricants. An air regulator controls the input air pressure. A 60 lb bleeder valve prevents excessive pressure in the lubricator conveyor. An air solenoid is used to shut-off the air pressure when the lubricator is not in operation.

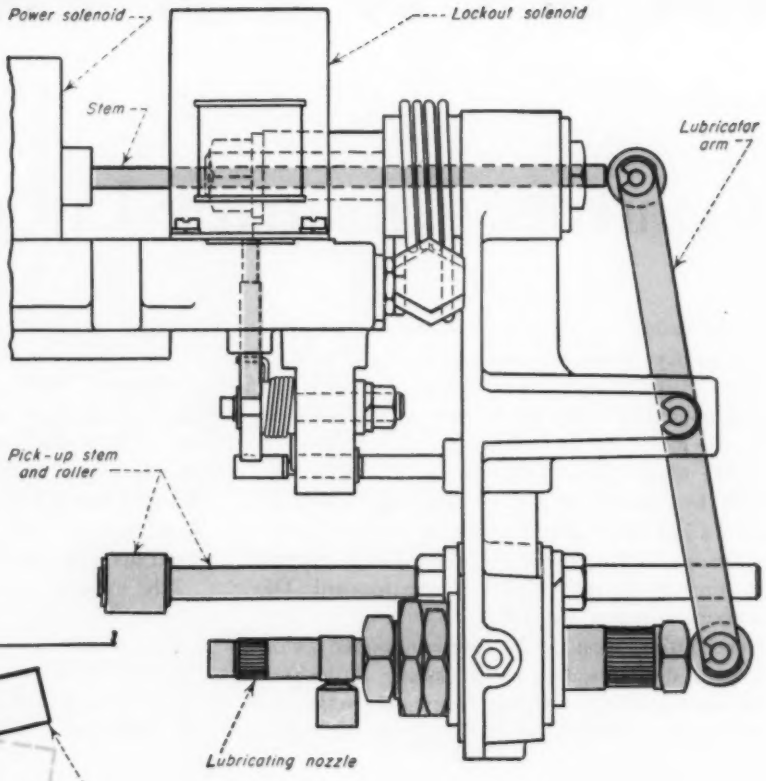


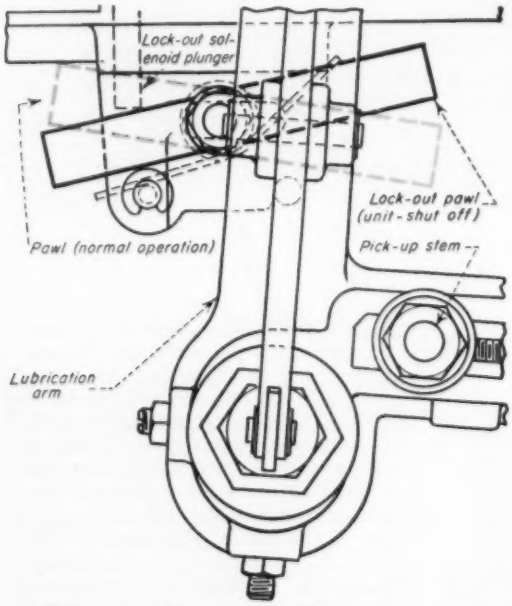
ANGULAR DISPLACEMENT of lubricator hub causes jack knife lever to contact precision switch which actuates the power solenoid. Forward movement of the solenoid stem starts lubrication operation. The hydraulic snubber in contact with lubricator mechanism insures smooth operation of the grease applicator. The conveyor trolley wheel lubricator has a right and left-hand lubricator assembly, mounted on opposite sides of the track. Wheels on both sides of the track are lubricated at the same time. One lubricant contains supplies for both assemblies, sufficient for 32,000 applications of 0.005 cu. in. each. The container has a follower plate for grease, an air regulator to control plant air line pressure, and a 60 lb bleeder valve to prevent excess pressure on the follower plate. Follower plate is used to insure an air prime permitting use of heavier greases and preventing air pockets.

(continued on next page)

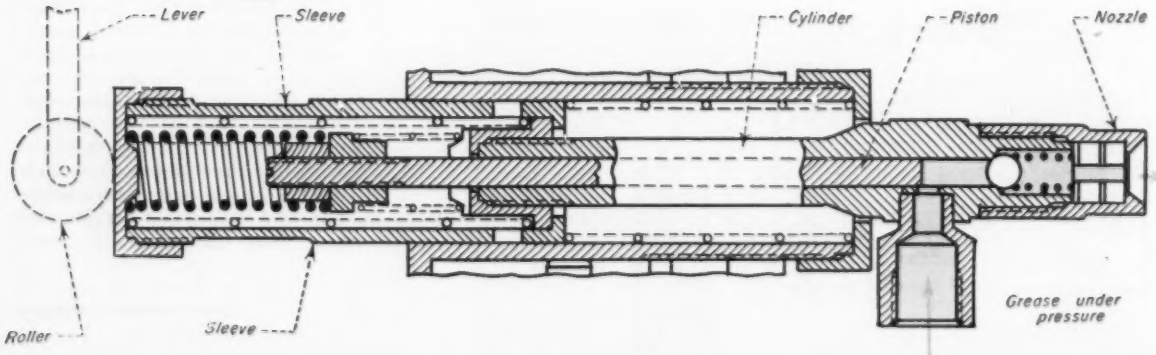
TROLLEY WHEEL contacts pick-up roller and raises the lubricator arm closing the switch to the power solenoid. Solenoid stem strikes the hinged lubricator arm driving the lubricating nozzle onto the wheel fitting and forcing a measured quantity of grease into the bearing. A lock out solenoid is energized when the unit is shut-off, automatically lifting the lubricator arm up so that passing trolley wheels cannot contact the pick-up arm.

LOCK-OUT PAWL shown in its unlocked displacement position with the lock-out solenoid energized. During normal operation, the solenoid is deenergized allowing the pawl (shown in color) to raise, permitting the pick-up stem on the lubricator arm to contact the moving trolley wheels.

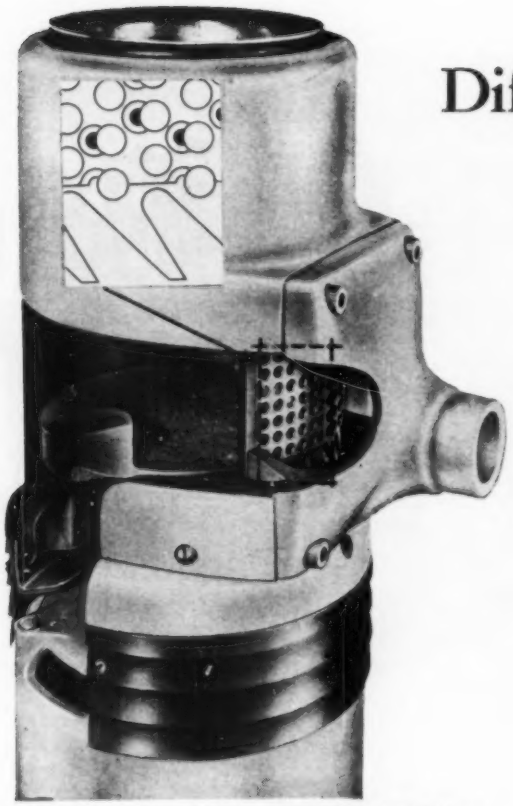




CROSS-SECTION OF GREASE GUN. When the lever tilts, the roller advances the sleeve carrying the lapped, self-lubricating piston and cylinder forward until the nozzle contacts the trolley wheel fitting. Further advancement of the sleeve moves the piston in the cylinder, causing displacement of the lubricant out of the ball check valve and into the wheel fitting. Lubricant is admitted through a side port to the cylinder under sufficient air pressure to feed the cylinder—with oils, 3 to 5 psi and for greases, up to 60 psi.



Different Grinding Action in Garbage Disposer

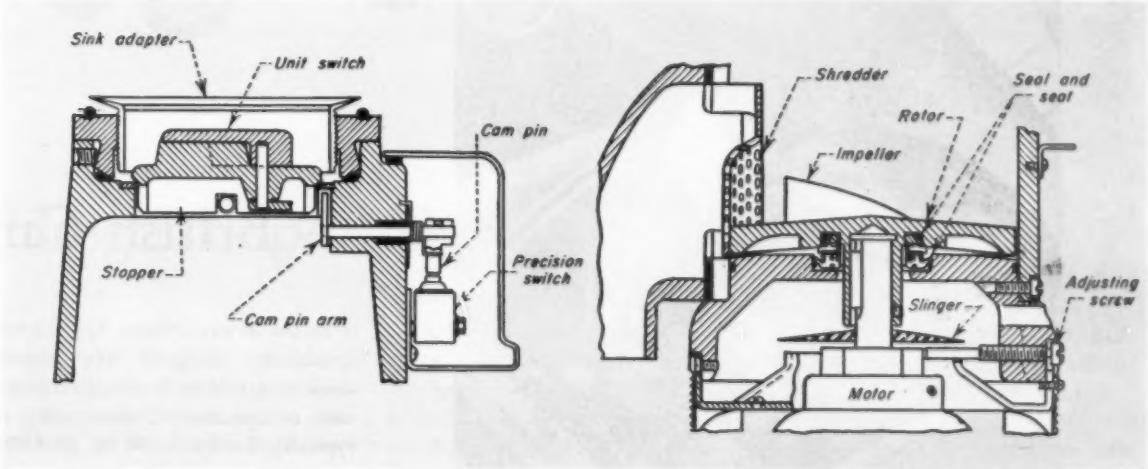


KEY to the disposer's new principle of grinding is the sizing screen. After waste is shredded into a homogeneous mass, water entering the unit as the disposer is turned on flushes out waste through the offset, reducing screen holes. This feature insures consistent-sized particles for discharge.

Use of sharp projections on the inside surface of a sizing screen to grind waste, instead of using the holes as part of the grinding element, permits Designers for Industry, Inc. to use a standard 1/3 hp split phase motor instead of a special capacitor motor. Other design features resulting from the use of the screen are the reduction in size and number of moving parts, and the obtaining of uniform particle size at the discharge end of the garbage disposer recently developed by them and Lockley Machine Co., New Castle, Pa.

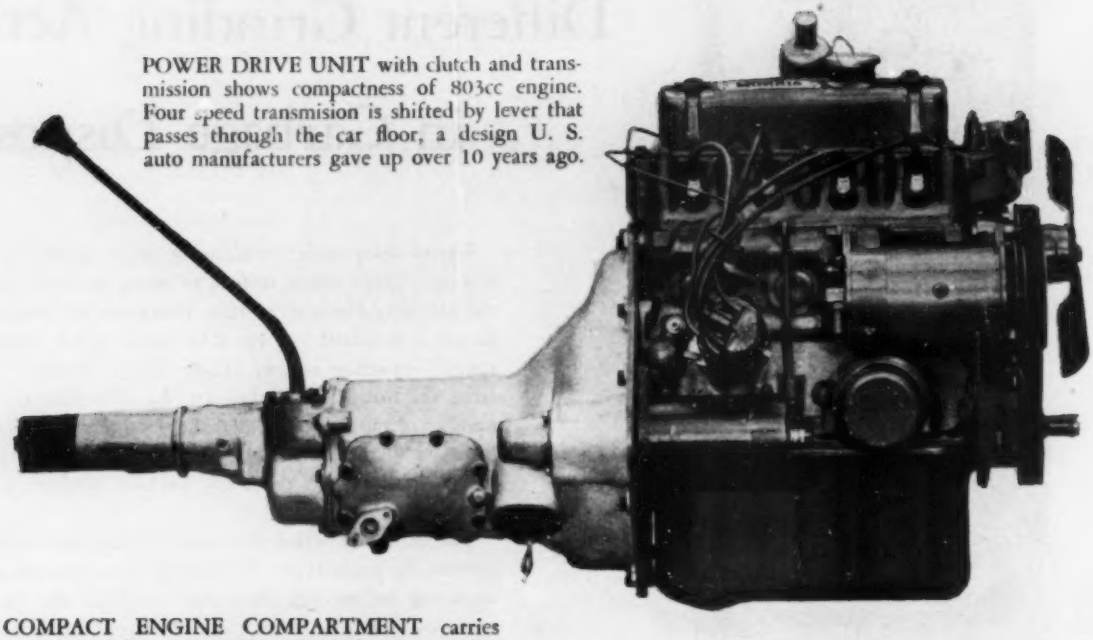
The turbulent action of a rotor impeller drives the waste against the projections. This results in a continuous disintegrating action but does not overload the motor because no grinding takes place between the impeller and the screen. And since the holes are not eroded by grinding, screen life is increased. In test, the unit disposed of 850 lbs of assorted bones, equal to over 10 years of normal service.

A screw-in type sink adapter for suspending the unit replaces the usual tie-down bolt installation and does away with the need for careful alignment. A one-piece combination switch acts as the strainer, stopper and starting switch.



THE ONE-PIECE combination switch controls the operation of the disposer. Turning the unit switch clockwise moves the cam pin arm and cam pin actuating the precision switch in the motor circuit. Removal of the combination switch enables the operator to gain quick access to the interior of the disposer.

PROGRESSIVE SHREDDING action that results from the rotor impeller forcing waste at a designed angle against projections on the screen permit excess capacity of the motor to act as protection against momentary overloads. A graphite seal and seat along with an umbrella type slinger keep water and waste from entering the motor windings.



POWER DRIVE UNIT with clutch and transmission shows compactness of 803cc engine. Four speed transmision is shifted by lever that passes through the car floor, a design U. S. auto manufacturers gave up over 10 years ago.

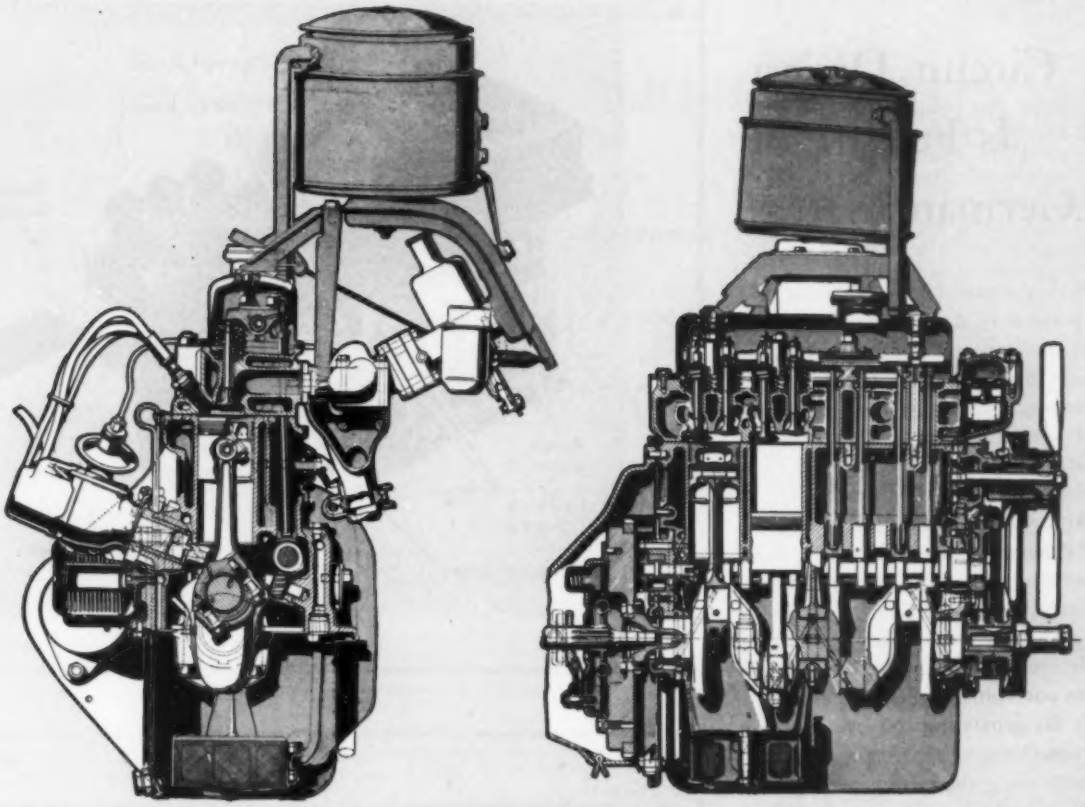
COMPACT ENGINE COMPARTMENT carries components for easy servicing. Large battery supplies 12v electrical system. Engine is mounted on pure rubber isolation—front mountings are in cylindrical shear, rear mounting is a rubber ring in a housing that surrounds the rear cover of the gearbox.

Morris Minor

British Car

In the Morris Minor, English car specifically designed for export markets, emphasis is placed on economy of operation. Engine rating is typically European, 30 hp at 4,800 rpm, only one-third the lowest horsepower offered by U. S. car manufacturers.

Styling features a high body silhouette, much different than that expected in foreign design, where



FOUR-CYLINDER overhead valve engine is built as a unit. Cylinders and crankcase form a single casting with the water jackets running the full length of the bores. Valves set in line in a detachable cylinder head, are operated by push rods from the forged steel camshaft. Aluminum alloy pistons have split skirts and an anodized finish. They carry three compression rings and a slotted scraper. Steel backed white metal bearings support the forged steel crankshaft, camshaft, and connecting rods. Centrifugal water pump and generator are driven by a v-belt; camshaft is driven by a roller chain, giving positive drive at reasonable cost.

Hinges Export Appeal on Economy

racy sport models are thought to predominate. But this is a traditional outline for standard British models.

For power, Morris uses a four cylinder, overhead valve engine with 7.2:1 compression ratio, a single plate dry clutch and four speed gear box. Engine block is a single casting with integral cylinders and crankcase. Water jackets run the full length of the bores.

In the gearbox, there is a central change speed lever mounted in the rear extension, which also acts as a plain bearing for the front yoke of the propeller shaft. Front yoke of the prop shaft is internally splined and slides on the gear box main shaft; there is no telescoping section.

Other features: 12v electrical system, electric fuel pump, down draft, single barrel carburetor, with combined induction silencer and oil bath air cleaner (models built for sale in Britain have a dry air cleaner).

Compared to U. S. models, the Morris Minor has a high rear axle ratio, 5.28:1 (U. S. models rarely exceed 3.50:1). There are no luxury accessories like automatic transmissions, power steering or power brakes. The car is designed for an economy-minded export market.

Circuit Design Is Feature of German Meters

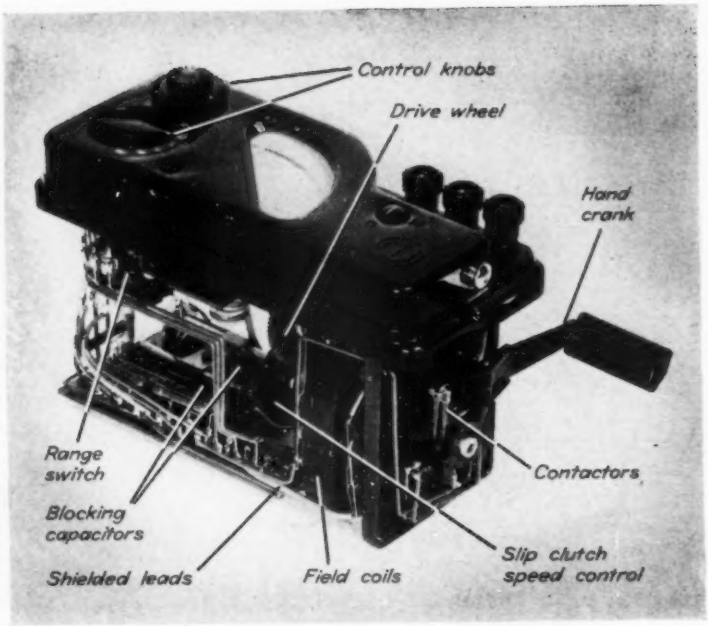
Several unusual design features incorporated in similarly built insulation and ground resistance testers permit the Metrawatt Company of Nurnberg, Germany, to construct high level indicating instruments measuring only $7\frac{5}{8}$ by $3\frac{3}{8}$ by 6 in., and weighing less than 5 pounds.

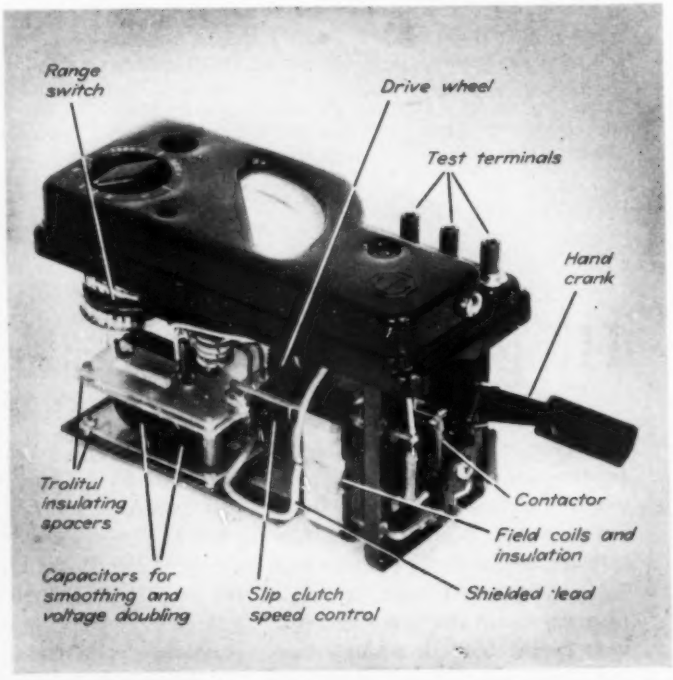
Although insulation testers of the self-generating type are not new, this new tester is capable of generating either 2,500 or 5,000 volts, a dual range to effectively check resistance at different voltage levels. To change from one voltage level to the other, only the generating coil connections require changing.

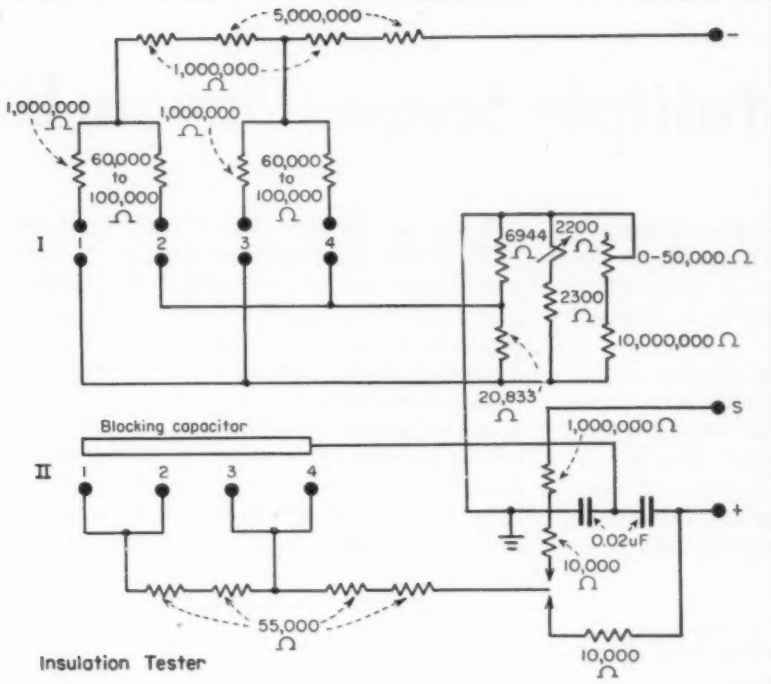
Built along the same general principles as the insulation tester, the ground resistance meter employs a design similar to that used in the application of high current shunts to metering circuits. This feature insures that the ground resistance is actually that being measured.

Both meters have a permanent magnet serving as the rotor and finely wound generating coils as the stator. This arrangement protects the stationary coils from any mechanical stresses. Rectification of a-c is done mechanically. The rectifier consists of a set of contacts keyed to the generator shaft which opens and closes the circuit. Timing of the contacts is so arranged that the contacts carry no current nor break any voltage.

Low terminal leakage is obtained by (1) using a thermosetting mica compound of high surface resistance and (2) by molding the entire assembly as one piece. Distributor for the testers is Electrodesign of Montreal, Quebec, Canada.

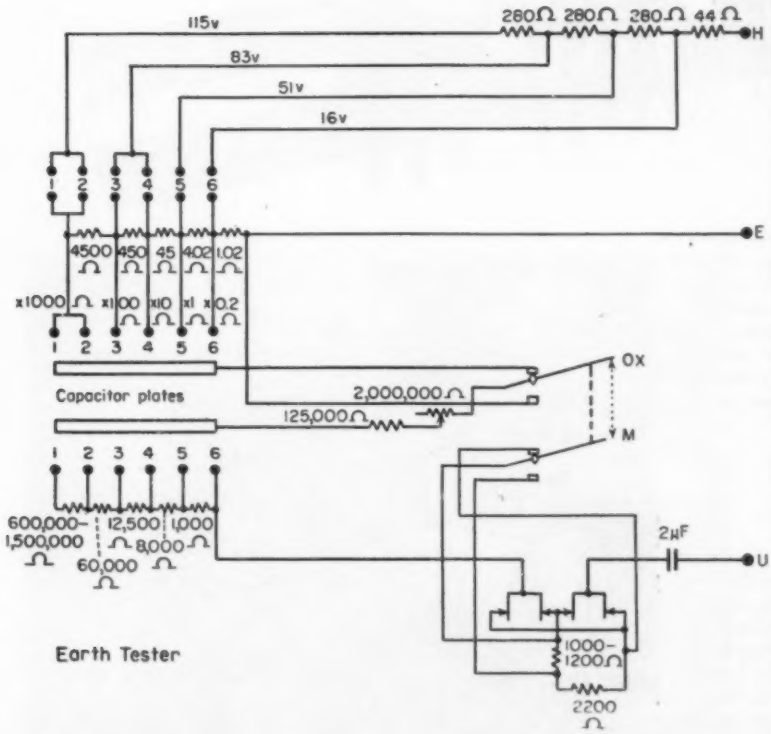






INSULATOR TESTER indicates up to 4,000 megohms using either 2,500 or 5,000 volt range. Two voltage levels enhance checking of insulation resistance for incipient faults. Instrument has high internal impedance to protect user from shock. But impedance factor increases time needed to fully charge capacitor.

INSULATION TESTER design employs two basic circuits to give upper and lower voltage values. Voltage doubler in rectifier circuit steps-up voltage to 5,000 volt level. For 2,500 volts, only two of four generating coils are used. Blocking capacitor protects system from unwanted interferences from d-c contact potentials.



GROUND RESISTANCE instrument employs the three electrode system of measurement. Tester uses short electrodes, one to two ft long, lightly driven into the ground. Generator sends inharmonic frequency of 93 cycles through ground to separate circuit from common power frequencies. A-c current is mechanically rectified by timed contactors on generator shaft.

GROUND TESTER circuitry is designed to indicate resistance of only one electrode to ground. High impedance blocks out unwanted resistance values from other electrodes in circuit. Capacitor placed in series with measuring potential insures that d-c potentials do not effect readings. The resistance of an auxiliary electrode can be high and yet will not enter the circuit calculations.

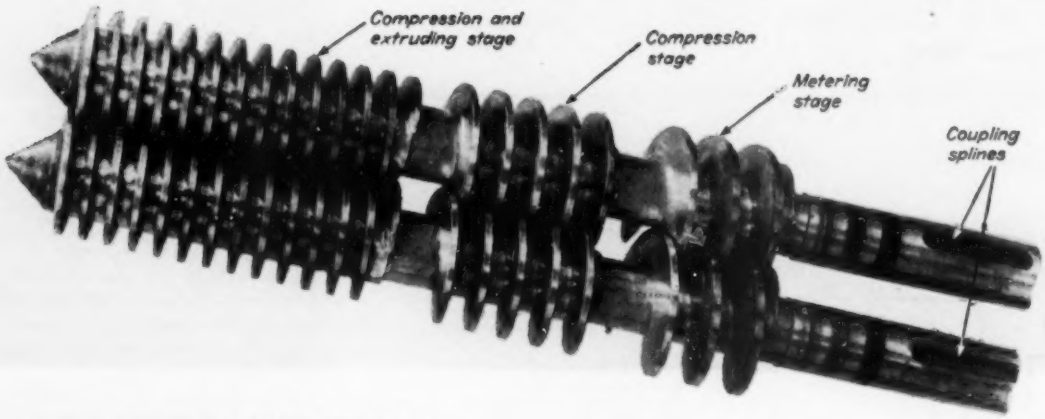
Multiple Screw Design Is

Twin-screw extrusion of plastic sheet, tubing and molded parts at rates up to 150 lb per hour is the unique design principle of the new, re-designed RC-100 Stokes-Windsor Extruder built by F. J. Stokes Company, Philadelphia, Pa.

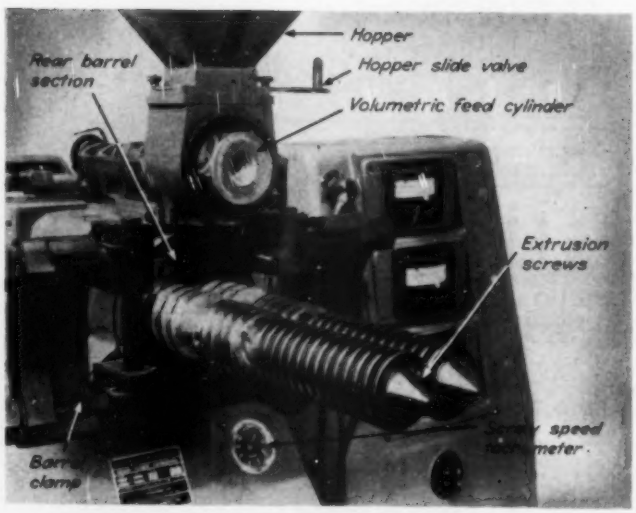
Basically, the major operating elements of the machine can be broken down into five parts: main gear box, secondary gear box, feed mechanism, extrusion head and electrical control. Assembly is based on maintenance ease and simplicity of operation. Service areas can be isolated from other sections without disturbing complementary parts.

Mounted on the plate steel base housing of the 10 hp variable speed motor are the main and secondary gear boxes. Located on top of the secondary gear section is the automatic feed mechanism and connected to output shafts from the secondary gear box is the extruding head. Electrical control cabinet contains heater controls and switches.

Simple operation is obtained by manually controlling extrusion screw speeds and utilizing an ampere load indicator to indicate machine loading. Hinge-type adapter plate facilitates die mounting and cleaning, and replacement of screen packs.

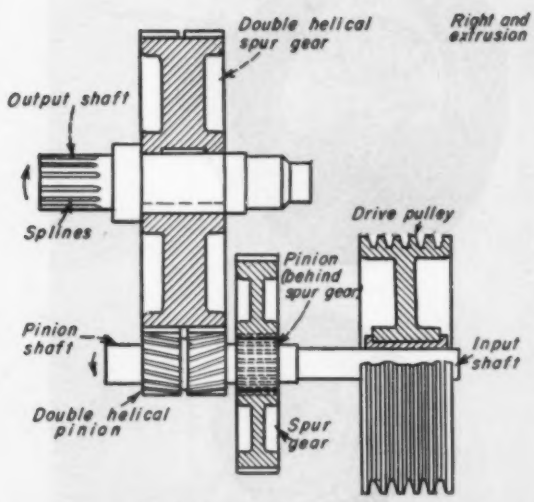


INTERMESHED EXTRUSION SCREWS insure positive flow through three operation stages. From back to extrusion end, screws decrease in outside and pitch diameters but increase in root diameter. Spline coupled shafts permit easy removal of screws without disturbing thrust washer assemblies. Normally, the screws need not be removed for cleaning. Controlled quantity of material is discharged into metering stage of screws.

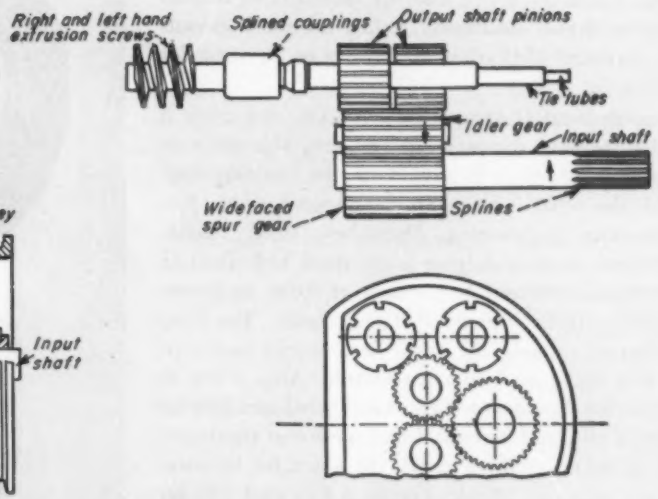


EXTRUSION SCREWS are backtightened by tie-tubes which run through bores of output shafts in secondary gear box. Rear barrel section is bolted to gear box frame and front barrel is attached to other section by heavy hinged barrel clamps. Power for the extrusion screws is transmitted through the main and secondary gear boxes from a variable speed motor on the machine base.

Basis of Plastic Extruder

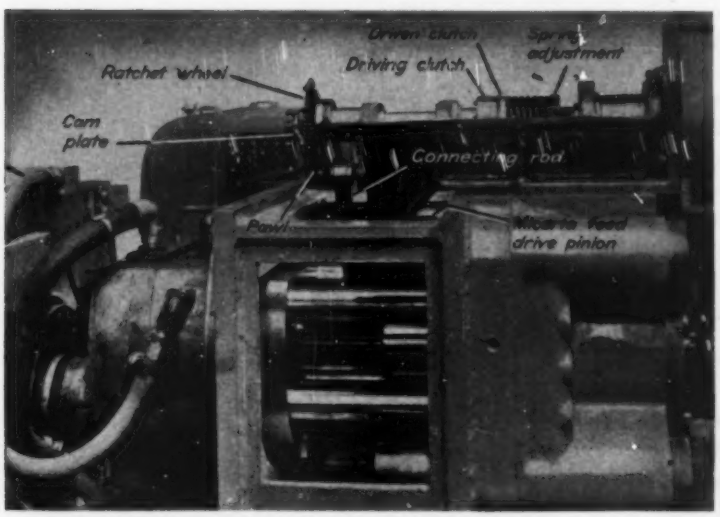


Main gear box



Secondary gear box

POWER FOR EXTRUSION SCREWS is transmitted through main and secondary gear boxes from variable speed motor mounted on hinged platform in machine base. Splined coupling connects main and secondary gear sections. But secondary unit is mounted on clamped slide to permit easy separation between the two gear boxes. Secondary gear box carries new thrust block arrangement for increased extrusion loads. Splined couplings are also used to connect output shafts to screws. Water cooled lubricant is supplied to thrust block and gears by double-helical pump driven by pulley input shaft in main gear box.



BUILT-IN CLUTCH acts to disengage the feed mechanism in event of overloading caused by oversize pieces of plastic material or contamination. Clutch spring is pre-set for desired slippage point depending upon type of material being extruded. When feed mechanism jams, lugs on driving clutch are forced out of indents on driven clutch, disengaging feed.

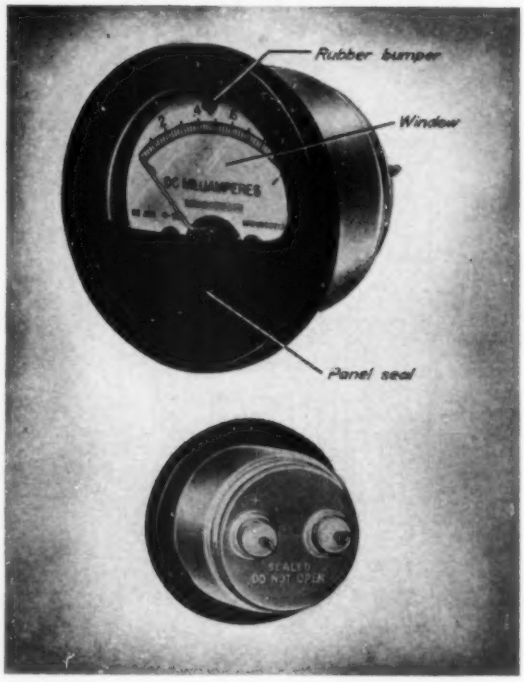
Constant feed can be varied by turning selection lever on front of machine to desired position. Lever location is translated to cam plate which is simultaneously positioned over ratchet wheel. Connecting rod attached to Micarta drive pinion gives constant stroke to ratchet pawl. Location of cam plate determines effective pawl engagement which in turn rotates volumetric feed cylinder keyed to rotor shaft.

Individual Shock Mounts "Ruggedize"

Another design approach to meeting the government's specification MIL-M-10304 for "ruggedized" instruments is De Jur Amsco Corporation's use of individually molded rubber shock mounts. Fitted into the shoulders of recesses spun into the drawn steel meter casing, the shock mounts enable a standard indicating mechanism to be used for this application.

The conventional D'Arsonval type of DC movement is shock-sealed between the two shock mounts. The entire assembly is secured in place by a standard wire retaining ring.

As with the other instruments developed for this program (Product Engineering, December, 1952; March, 1953), De Jur's meter undergoes severe shock and vibration tests. Instrument-vibrated in 3 planes of 0.030 amplitude at frequencies from 1 to 60 cycles per min. Tumbling test consists of rotating the meter in a special vane-type tumbler at a speed of 5 rpm for 45 min. Also, a 400 lb hammer moving through a 5 ft arc strikes panel on which the instrument is mounted. Thermal shock consists of alternately submerging the meter in 0 and 85C tap water, for 10 cycles —each cycle being for 20 min. Finally, a 4 oz steel cylinder is dropped from an 8 in. height on to the instrument face to check scale window strength.

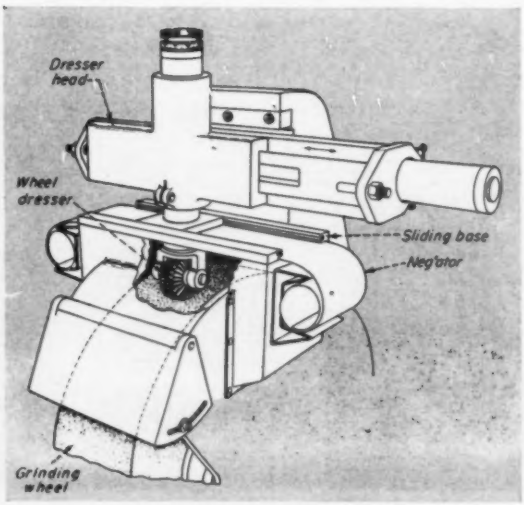


Neg'ators Used for Slot Closure and

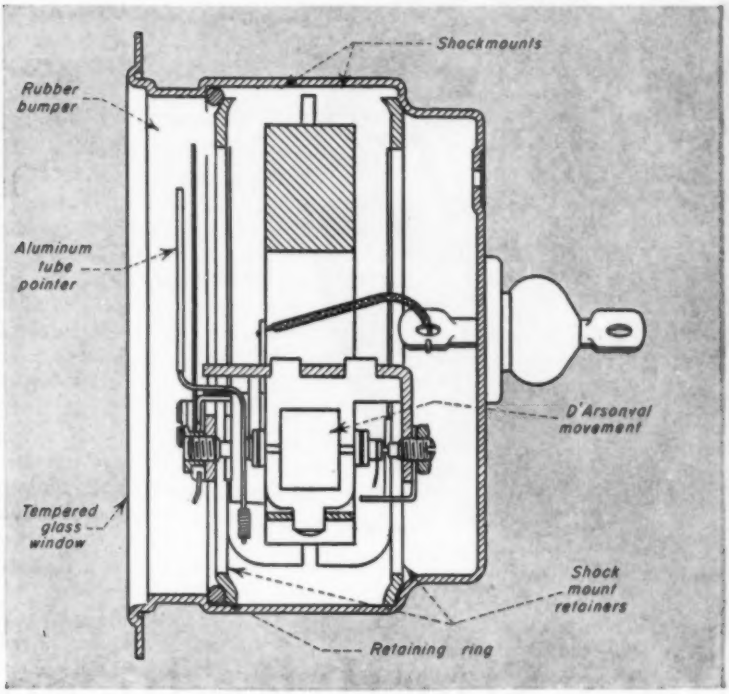
Two machine tool concerns, the Van Norman Company and the Pratt & Whitney Co., have incorporated the use of Neg'ators to replace auxiliary machine members. Utilizing the basic advantage of Neg'ators—that of exerting a constant and equal force throughout the length of the spring and obtaining a constant torque independent of deflection —both companies produced a more compact design.

The Van Norman Co. replaced two neoprene strips mounted on "window-shade" rollers with two 3 in. wide Neg'ators to effectively close the slot at any position of their wheel dresser head. Pratt & Whitney used two Neg'ators to replace a dead-weight system to insure constant belt tension on their new grinding machine.

Pratt & Whitney used Neg'ators because it was necessary to rotate the whole vertical grinding system axis to maintain the grinding action normal to an increment of a twisted airfoil at any given time during the grinding cycle.



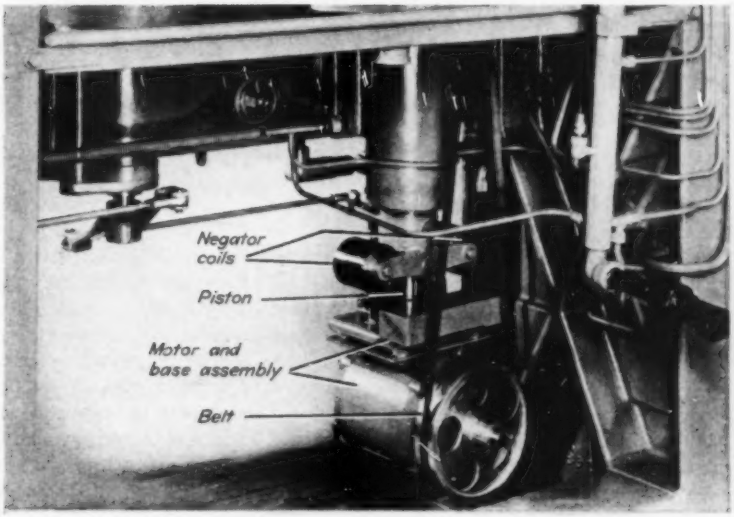
Another Precision Instrument



TEMPERED GLASS WINDOW is induction soldered to the rim of the instrument for hermetic sealing. A rubber panel seal also serves as an auxiliary shock mount and protects the indicating mechanism from a direct blow. A small rubber bumper inserted in a hole in the panel acts as a third suspension mount for the panel and gives some shock protection for the window.

SPECIALLY MOLDED rubber shock mounts contain the basic D'Arsonval movement. Assembly consists of dropping a retaining washer into the shoulder recess, placing one shock mount on the retainer, positioning the indicator mechanism on the mount and then sealing the movement with another mating shock mount, retaining washer and lock ring.

Counter Balancing Applications



NEG'ATORS lie in a slot on either side of the sliding base of Van Norman Company's hydraulically operated wheel dresser. Use of negators insures that the slot is positively closed at any point of dresser head travel (far left).

TWO NEG'ATORS mounted on bushings partially counterbalance the weight of the motor and base assembly to give the proper belt tension without the need for adjusting for belt stretch. Remainder of weight gives a constant tension on the belt for proper tracking of the belt on the contact wheel.

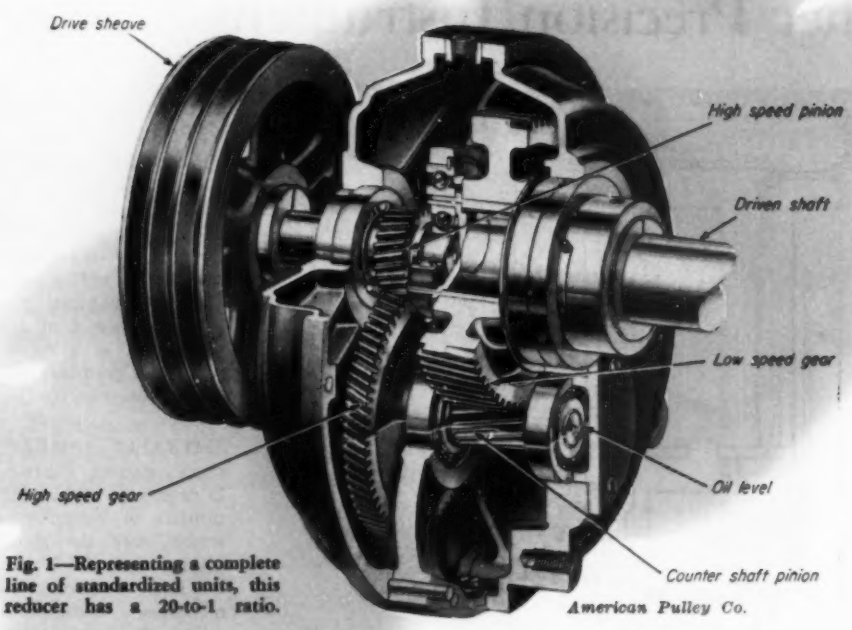


Fig. 1—Representing a complete line of standardized units, this reducer has a 20-to-1 ratio.

Shaft Mounted Speed Reducers

E. J. McCLOSKEY
American Pulley Company

SEVERAL TYPES of equipment are available to provide a speed reduction between a driving and driven unit. Among these are V-belts, gearmotors, worm reducers and separate gear reducers. V-belts are desirable because of their low cost, quiet operation, easy installation and complete freedom from lubrication requirements.

One shortcoming of V-belts, however, is that their efficiency drops off sharply at slow speeds. Rarely can they be used at 150 rpm or less. Thus, shaft mounted speed reducers have been developed to extend the effective operating range of V-belts to slow speed equipment and still keep the premiums on space, cost and efficiency at a minimum. These shaft-mounted units are applicable to machines that operate in the range of about 5-150 rpm, and transmit up to about 45 horsepower. They all have fixed speed ratios, but adjustable speed sheaves can be used with them to get speed variations of as much as six-to-one.

Like most units of this type, the one in Fig. 1 is a double reduction type. Speed of the driven sheave is reduced through two trains of single helical gears: high speed pinion, high speed gear, countershaft pinion and low speed gear—giving a total reduction of 20-to-1 on the driven shaft. Other units have ratios from 13-to-1 to 20-to-1, depending on the size and manufacturer. The input and output shafts of this type are concentric so that the top oil level is always below them, and the bearing seals do not operate against a head of oil.

To supplement the inherent ability of V-belts in withstanding shock loads, most manufacturers equip their units with mechanical devices for overload protection. The one in Fig. 3 consists of a plate pivoted on the torque arm that snaps over a stud connected to the reduction unit housing. This plate is restrained from movement by a spring-loaded plunger until an overload occurs beyond the designed torque rating of the installation. At that instant the plate pivots, releases the stud, and the torque arm falls free, allowing the reduction unit to revolve. When the overload condition has been corrected, the machine is put back in operation simply by putting the torque arm back in place.

This release operates equally well whether it is in compression or tension, whether the reduction unit is installed horizontally or vertically, and whether the rotation is clockwise or counter-clockwise, or reversing.

When service conditions require a device to prevent reverse rotation, speed reducers can be equipped with internal backstops. External backstops can be put on the driven machine.

Performancewise, shaft-mounted

speed reducers offer the high efficiency of helical gears combined with the efficiency of V-belt drives on the high speed side. The efficiency of the shaft-mounted unit itself is about 98 percent, and the efficiency of the complete drive, including the V-belt drive, is approximately 96 percent over most of the speed range.

Installation

In designing equipment to incorporate shaft-mounted reducers, provision must be made for (*a*) space to be occupied by the unit, (*b*) accessibility for checking oil level and for changing oil, (*c*) proper shaft length on which to mount the reducer and (*d*) attachment of torque arm. Actually, the space requirements are little more than would be required for a standard V-belt drive. The smallest size reducer is only 9¼ in. from top to bottom; the largest is only 32½ inches. They are compact units, requiring no special foundations or supports, further reducing space requirements and helping reduce manufacturing costs of slow speed machinery. Compared to other types of slow speed power transmission equipment, they are easy to incorporate into machine designs.

Interchangeable bushings adapt output hubs to shafts of various sizes—in many cases, the designer can specify one size reducer for different models and sizes of the same machine even if shaft diameters vary, providing power requirements are similar.

Shaft length required depends upon the design of the speed reducer selected. Some require only standard shaft lengths (twice the shaft diameter plus clearance) for mounting.

Most speed-reducers are mounted in a horizontal position as shown in Fig. 2. However, some applications make a vertical mounting desirable.

Overhung Load

Overhung load, that is, the weight of the reducer plus the pull of the belts, is negligible. The largest single force acting on the driven shaft is the reactive force of the torque arm, and the torque arm can usually be placed in a position which virtually cancels out the overhung load.

Actually, the forces imposed on the shaft are usually less than the forces exerted by a chain drive doing the same job. The chain pull has no reactive force to counteract it, as does a shaft-mounted reducer. Furthermore, the sprocket for a chain assembly is ordinarily at the center of the shaft extension, whereas the torque arm on a reducer is mounted on the inside of the reducer next to the driven machine bearing, bringing the resultant force closer to the bearing.

This can be proved for any specific installation by actual calculations and has further proved itself by the fact that no excessive wear has been experienced on driven machine bearings in thousands of installations of reduction drives. Many bearing troubles formerly experienced with slow speed chain installations have actually been eliminated through a use of reduction drive and proper location of the torque arm to achieve the best results.

Selection

Selection of a shaft-mounted speed reduction drive for a given application requires the following information: (1) Prime-mover horsepower and speed; (2) Desired rpm of driven unit; and (3) Service classification of driven machine.

Literature is available from each of the manufacturers for determining which one of their units satisfy any given combination of these data.

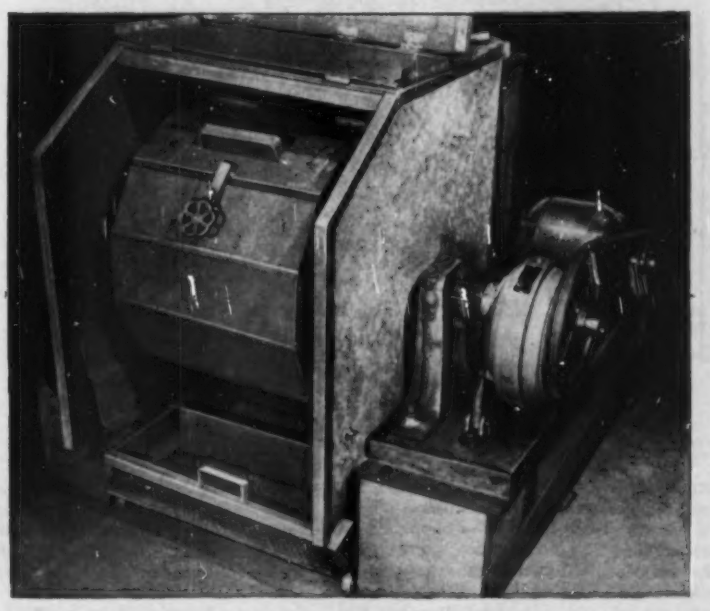
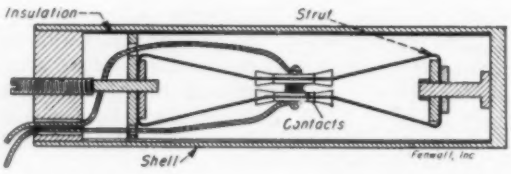


Fig. 2—Typical horizontal installation on a tumbling barrel. Note compact, simple installation. Motor speed is 1,750 rpm; driven speed 45 rpm.

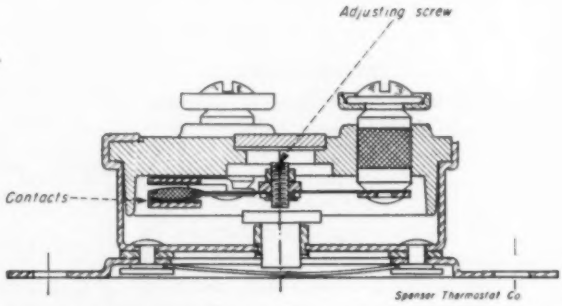
Fig. 3—Torque-arm overload release supplements inherent protection of V-belts against sudden overloads. It is instantaneous in action and easily reset after it is tripped.

Temperature Regulators

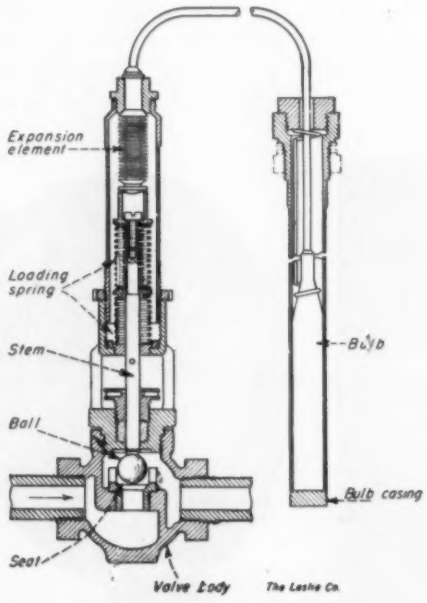
L. C. BLAUVELT
Hoffman LaRoche



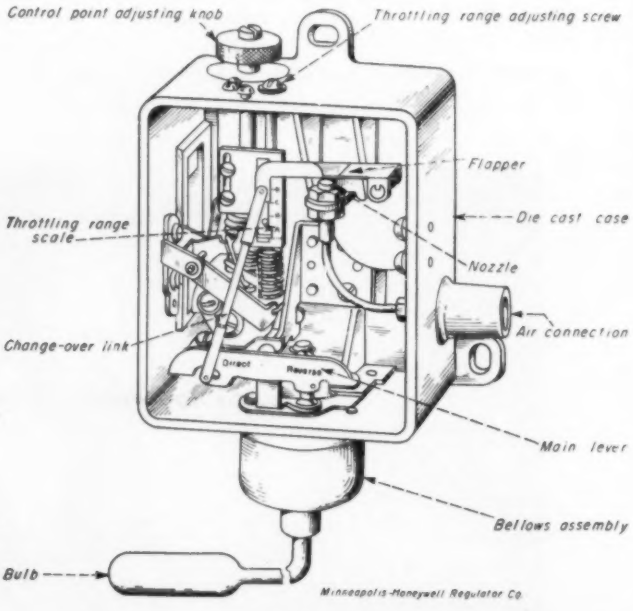
1. Bimetallic device is simple, compact and precise. Contacts mounted on low-expansion struts determine slow make-and-break action. Shell contracts or expands with temperature changes, opening or closing the electrical circuit that controls a heating or cooling unit. Adjustable and resistant to shock and vibration. Range: —100 to 1,500 F. Accuracy: Operates on less than 0.5 deg. temperature change.



2. Typical inclosed disk-type, snap-action control has fixed operating temperature. Suitable for unit and space heaters, small hot water heaters, clothes dryers and other applications requiring non-adjustable temperature control. Useful where dirt, dust, oil or corrosive atmosphere is involved. Available with various temperature differentials and with manual reset. Depending on model, temperature setting range is from —10 to 550F and minimum differential may be 10, 20, 30, 40 or 50F.

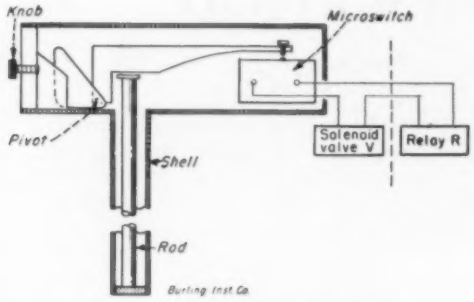


5. Self-contained regulator is actuated by expansion or contraction of liquid or gas in temperature sensitive bulb which is immersed in medium being controlled. Signal is transmitted from bulb to sealed expansion element which opens or closes the ball-valve. Range: 20 to 270 F. Accuracy: ±1 deg. Max. press. 100 psi. for dead end service, 200 psi continuous flow.

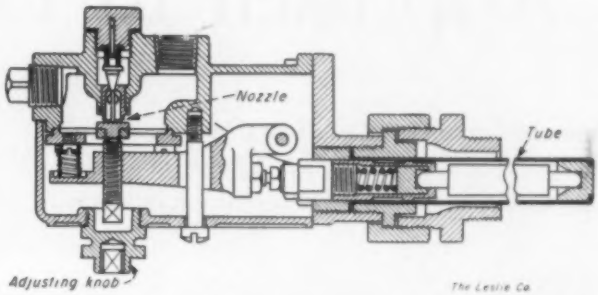


6. Remote bulb, non-indicating regulator uses a bellows assembly to operate a flapper. This allows air pressure in the control system to build up or bleed depending upon the position of the change-over link. Unit can be direct or reverse acting. Control knob adjusts the setting and the throttling range adjustment determines the percentage of the control range in which full output pressure (3-15 psi) is obtained. Range: 0-700 F. Accuracy: About ±0.5 percent of full scale range depending upon installation factors.

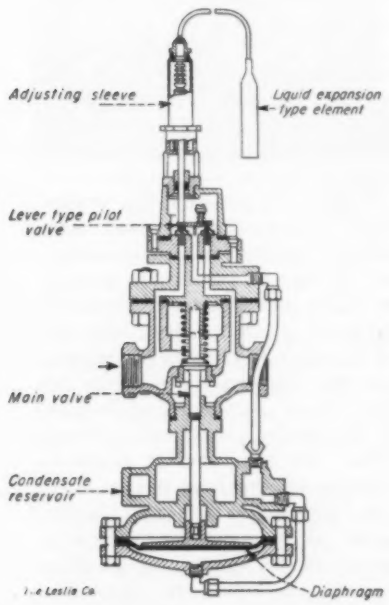
Temperature regulators are either of the on-off or throttling type. The characteristics of the process determine which should be used. Within each group, selection of a device is governed by the accuracy required, space limitations, simplicity and cost.



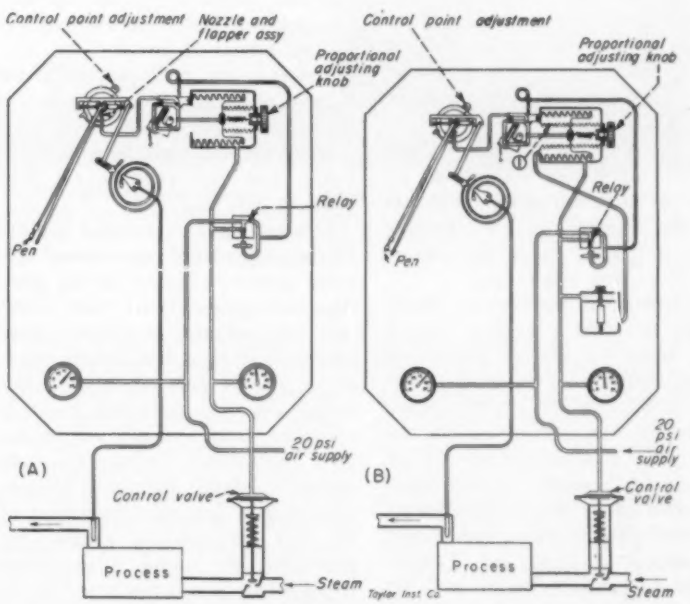
3. Bimetallic unit has rod with a low coefficient of expansion and a shell with a high coefficient. Microswitch gives snap action to the electrical control circuit. Current can be large enough to operate a solenoid valve or relay directly. Set point is adjusted by knob which moves the pivot point of the lever. Range: —20 to 1,750 F. Accuracy: 0.25 to 0.50 degrees.



4. Bimetallic actuated, air piloted control. Expansion of rod causes air signal (3-15 psi) to be transmitted to a heating or cooling pneumatic valve. Position of pneumatic valve depends upon the amount of air bled through the pilot valve of the control. This produces a throttling type of temperature control as contrasted to the on-off characteristic that is obtained with the three units described previously. Range: 32 to 600 F. Accuracy: ± 1 to ±3 F depending upon the range.



7. Lever-type pilot valve is actuated by temperature sensitive bulb. Motion of lever causes water or steam being controlled to exert pressure on a diaphragm which opens or closes the main valve. Range: 20 to 270 F. Accuracy: ±1 to 4 degrees. Pressure: 5-125 psi, steam; 5-175 psi, water.



8. Two recording and controlling instruments with adjustable proportional ranges. In both, air supply is divided by a relay valve. A small part goes through nozzle and flapper assembly. The main part goes to the control valve. Unit *B* has an extra bellows for automatic resetting. It is designed for systems with continuously changing control points and can be used where both heating and cooling are required for one process. Both *A* and *B* are easily changed from direct to reverse acting. Accuracy: One percent of range of —40 to 800 F.

The Multi-Purpose Grease Approach to Lubrication

Lithium and barium greases. How they compare with special purpose types such as those with calcium, sodium, and aluminum bases. Where they can be used.

GEORGE H. LINK
Lubrication Engineer
Shell Oil Company

SOME YEARS AGO the military organizations became interested in the development of a multi-purpose grease as one means of solving the problem of handling an almost unlimited number of special type greases. About the same time, industry and the oil companies started in the same direction, an objective which led to the introduction of lithium grease to industry in 1949. The accompanying graph shows the trend since then.

In the case of one producer, Shell Oil Co., current figures show that 60 percent of its overall grease production is in the lithium-type, multi-purpose grease, a product combining lithium with 12-hydroxy stearic acid.

Department of the Interior figures support this trend, showing that in 1951, some 34 million pounds of lithium grease were produced, about 102.5 million pounds in 1952, with a forecast of 135 million pounds for 1953. The Aluminum Company of America, for instance, handles about 75 percent of its grease requirements with multi-purpose grease, and Wright Aeronautical Division of Curtiss-Wright Corporation, meets over 95 percent of grease needs with a lithium base type.

Besides greatly reduced inventories, there are many advantages to using one grease for a multiplicity of purposes. From the manufacturers standpoint, volume production, simplified application problems, reduced packaging and distribution costs, and concentration of research and test facilities are particularly desirable.

From the users standpoint, a multi-purpose grease can replace multiple brands and weights with one type for as many as 90 percent of all requirements; not to mention the economic advantages of volume buying of one type. There may also be a more simplified storage and dispensing system, extended lubrication periods, reduced consumption, and importantly, fewer misapplications of grease.

Before a true multi-purpose grease became possible, it was necessary to develop a soap base that was water resistant (at least equal to calcium and lime), and heat resistant (at least equal to soda base).

Lithium grease was found to have all the properties of conventional specialty greases; a higher melting point than soda grease; better water resistance than calcium; and higher resistance to breakdown than barium grease. It can also be pumped easier at low temperatures, an important point in automatic grease systems, and in outdoor applications. Perhaps the tight supply of lithium, lightest of all metals and most important ingredient of the best multi-purpose greases, has prevented the trend from being stronger than it is at this time. Of the 80-company grease industry, 25 are at present manufacturing lithium base grease, and the demand is increasing.

The Aluminum Company of America has, since 1947, reduced its grease requirements from 125 brands and grades to approximately ten, and at the same time realized reduced grease consumption, increased bearing life, and simplified inventory and purchasing practise. Their multi-purpose greases are used in all types of anti-friction bearings, from 10 rpm to 3,600 rpm, operating at temperatures anywhere from —20 F to 150 F, and varying in size from one to 36 in. in diameter. These bearings are used in their mining, smelting, hot and cold rolling, extrusion, deep drawing, and foundry divisions transmitting steady rotational loads as well as high shock and vibrating loads. Multi-purpose greases are also used to lubricate all journal bearings of the 360 degree type, and are used in water pump bearings, and in the presence of air and gas in grease lubricated plug valves.

Of the other than multi-purpose grease used, are the inexpensive calcium soap cup greases, and the barium grease, which has good water and heat resistance, and comes close to meeting multi-purpose requirements.

Factors to be considered in making grease recommendations include temperature, speed, load, contaminants, and the type of bearing. In general, the higher the temperature, the harder the grease, as well as the higher the oil viscosity. At extremes of temperature, the soap base or thickener becomes more important and, because of the unique properties of certain greases, the grease quality is not as critical as in other lubricants.

In anti-friction bearings, higher speeds call for somewhat harder consistency of the grease, and in plain bearings, the higher the speed, the softer the consistency. When the load is higher, the oil viscosity is higher.

Water is the most frequently encountered contaminant, and here the grease must be able to tolerate moisture without serious breakdown.

In general, anti-friction bearings require smooth or short fiber greases, whereas plain bearings may be lubri-

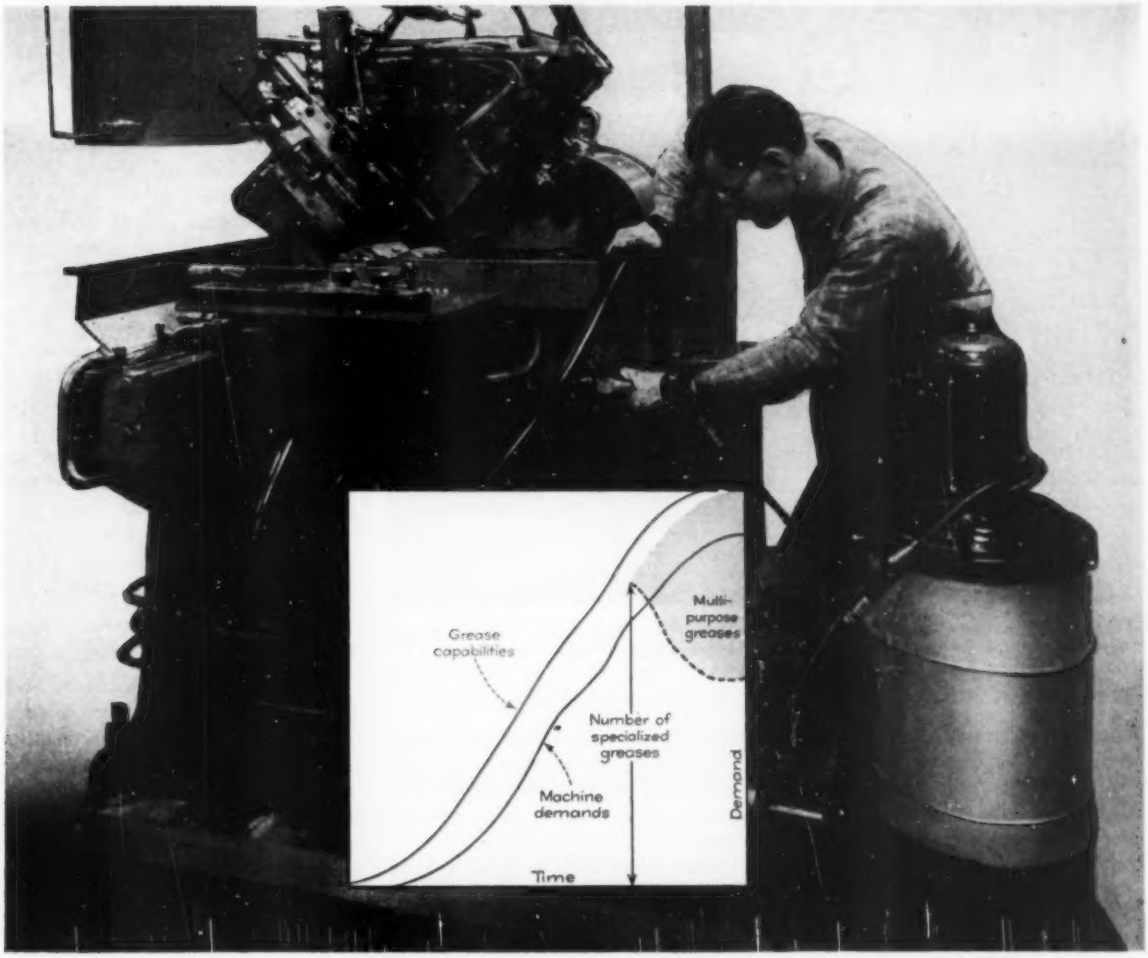


Fig. 1 (Insert)—The demands of lubricating greases have increased in number and complexity in the past half century. Specialized greases were produced, but today multi-purpose greases are reducing the number of specialized grades necessary. Fig. 2—Machine tools like this automatic shell trimmer are adaptable to lithium multi-purpose grease of the type used to handle other functional equipment, motors, and processing equipment.

cated by either fibrous or smooth greases. Anti-friction bearings generally require "channeling" greases, which explains why high speed bearings call for the harder types of grease.

Since the harder greases supply the best seal, they are recommended in applications such as valves, pipe joints and bearings, or equipment operating in applications subject to external contamination. Universal joints and industrial couplings, because of centrifugal forces, dictate the use of greases which resist separation. Generally, the longer the fiber and the higher the oil viscosity, the greater the resistance of the grease to separation when it is subjected to centrifugal forces. As a rule, the higher the shock, the harder the consistency and the higher the extreme pressure properties.

In looking at the most commonly used specialty greases up to the advent of lithium multi-purpose greases, it should be realized that the metallic soap molecule's action on the oil in the grease generally gives it whatever unique characteristics it may possess. The most common metals used in grease manufacture have been calcium, sodium, aluminum, and barium, leading up to the use of lithium, lightest of the metals. See table.

In reviewing their characteristics, the following factors should be considered in order to establish the properties of a grease: (1) The kind of metal atom in the soap or soaps; (2) The fats or fatty acids from which the soap is made; (3) The percentage of soap used; (4) The characteristics of the petroleum oil used; (5) Water, glycerin and other materials that form an integral part of the original mixture; (6) Chemical "additives" that are added for specific purposes; and (7) Techniques used in manufacturing.

When classified on the basis of the metal atom used, the following types may be considered:

CALCIUM (LIME) SOAP GREASES

Chief characteristic of a calcium soap or "lime" base grease is its insolubility in water and hence its good water resistance. They are smooth, "buttery" and have short fibers. Be-

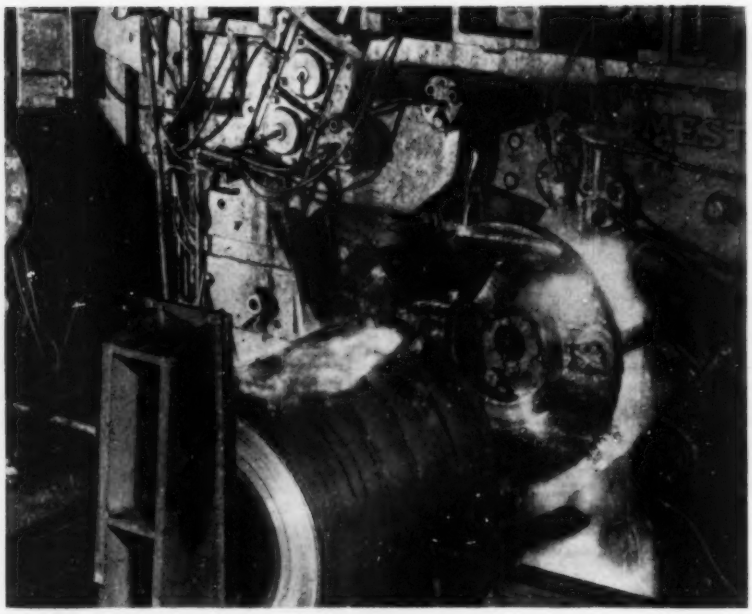


Fig. 3—Multi-purpose grease stands up adequately where heat, speed, shock load, and water are continuously present, such as in this installation of strip rollers.

cause most calcium greases require a certain amount of water to make the soap and oil mixture stable (keep them from separating), under ordinary conditions they cannot be used continuously at temperatures much above 160 F or else they lose this "water of hydration" and show poor mechanical stability. Thus, multi-purpose designation is not logical.

Calcium greases are variously classified as cup grease, pressure-gun grease, or heavy-duty lime grease. The better grades are much in demand for economical, general purpose lubrication of plain bearings where temperature and loads are light.

Water-free calcium greases, such as calcium acetate have been developed which can be used at higher temperatures (melting point 300-500 F), but have only fair mechanical stability.

SODIUM SOAP GREASES

The sodium soap used in "soda base" greases is fibrous in texture, relatively water soluble, and should not be used where excessive moisture is present. In general, sodium greases have fairly high melting or dropping points —above 325 F.—which allows them to be used at fairly high temperatures as compared with some other greases.

The length of the fiber in sodium greases can be varied within wide limits by manufacturing procedures. This permits the manufacture of both smooth and fibrous products adaptable for use under a wide range of conditions.

Short fiber sodium greases have been used extensively as lubricants for ball and roller bearings, such as automotive wheel bearings which, because of the heat generated when the brakes are applied, need a highly heat-stable grease that will not melt and run out onto the brake linings.

Long fiber sodium greases are frequently used in lubricating plain bearings and other sliding surfaces that operate at relatively high temperatures (200 F and above). They are not recommended for high-speed anti-friction bearings because the fibers tend to "wrap" around the cages.

ALUMINUM SOAP GREASES

Perhaps the most outstanding characteristic of this type of grease is high adhesiveness or "tackiness." It is smooth to stringy and never fibrous. This is because the aluminum soap fibres are microscopically small—perhaps the shortest of any used in grease making.

Aluminum greases are not suitable for use at sustained temperatures much above 160 F. In the past they were fairly popular as lubricants for automotive chassis and for cams, chains, and oscillating surfaces where less adhesive greases failed to "stay put."

BARIUM SOAP GREASES

These greases became popular because they combined several of the best characteristics of the older, previously described greases, and, until the advent of lithium greases, were the best so-called multi-purpose greases.

They have high melting points (about 350 F) and can be successfully used at temperatures 75 to 100 degrees higher than corresponding older-types of sodium soap products.

They are smooth to fibrous in texture and do not soften unduly at temperatures approaching their high melting points. Actually, it was because of the development of barium greases that the multi-purpose approach was born.

MIXED BASE GREASES

In the past, many greases have been prepared with two or more metallic soaps in combination to produce a lubricant that has some of the desirable properties of each of the components. Perhaps the most successful of these has been a grease containing a small percentage of calcium in a sodium grease. Grease using 16 percent sodium soap and 2 percent calcium soap, and highly inhibited against oxidation by the use of additives, have been used for packing the so-called "life sealed" or pre-lubricated anti-friction bearings.

Among the other soap combinations used are aluminum-sodium, calcium-zinc, lithium-calcium, lithium-calcium-sodium, and lithium-sodium. Most of these have been developed for highly specalized applications and many are still on an experimental basis.

LESS FREQUENTLY USED GREASES

Among the other metallic soaps, other than those mentioned, is strontium. This soap forms a grease similar to barium, but is more expensive because of the scarcity of strontium compounds.

A particularly hard type of grease known as "block" grease contains a high percentage of soap (30 to 50 percent) with a high viscosity oil. These almost solid greases are used for lubricating plain journal bearings such as

those in railroad locomotive driving journals, calender rolls, cement mills and the like.

Lead-soap-oil mixtures have, in the past, been incapable of forming the fibrous, lattice-like structure usually associated with grease. Generally the lead has been added for pressure purposes and there has been no gelling.

However, by using a 12-hydroxy stearate, it is possible to use lead soap and have it act as a thickening agent. This type of grease is being used on plain journal bearings where it can be handled as a grease but at operating temperatures becomes a fluid.

A number of grease bases have been developed quite recently which are nonorganic in origin; that is, they do not employ fats or fatty acids. Among these are silica aero-gels and the Bentonite clay types. Because of the inorganic nature of these bases, the greases formed do not exhibit the melting points found in the soap base greases, and are accordingly suited to certain high temperature lubrication.

LITHIUM SOAP GREASES

The most recent, as noted, type of metal soap grease is the lithium soap, and its current field performance shows a wide range of application. Lithium soap greases are buttery to stringy in texture, with high melting points of about 350 F. Certain especially formulated lithium greases, particularly those containing lithium 12-hydroxy stearate made from hydrogenated castor oil, can be used for long periods at temperatures up to 300 F without ill effects. This grease shows good resistance to water, and also to breakdown or softening by working.

However, the characteristics of lithium greases may vary widely, depending upon their composition (that is, the fatty acid used, the percentage of soap, and kind and viscosity of petroleum oil used), as well as manufacturing technique. Some lithium greases may be used at very high temperatures and, by contrast, for aircraft lubrication at temperatures as low as —100 F.

Certain types of lithium soaps give a grease with the greatest mechanical stability of any product so far developed (withstanding as many as a million strokes in the ASTM Worker Test, without breakdown). Such greases combine the best properties of the other greases—high melting points, water resistance, good "dispensability," small low temperature torque, and high mechanical stability.

The problem of multi-purpose greases can be attacked from either of two directions: (1) The usual and long established "specialized" approach where each applicant is dealt with individually and a special grease recommended, and by consolidation arriving at the optimum position. (2) The multi-purpose approach, where the entire unit, whether a single machine or a number of different machines are treated first, from the all-purpose point of view using one grease for all applications, and then by excepting those applications where special conditions require a special grease.

Principal Lubricating Greases—Effect of Metallic Soaps

Specifications	Older Specialized Greases				Multi-purpose Greases	
Type of Soap Base	Calcium	Sodium	Mixed Base	Aluminum	Barium	Lithium
Texture	Smooth, buttery	Fibrous or buttery		Smooth to stringy, never fibrous	Smooth to fibrous	Smooth to buttery
ASTM Dropping Point (approx.)	190 F	325 F+		185 F	350 F+	350 F+
Service Qualities: Max continuous usable temps. (average)	160 F	250 F+		180 F	275 F+	275 F+
Water resistance	Good	Fair	Specific data not given here because of wide varieties in unobtainable mixtures	Good	Good	Good
Resistance to breakdown and softening by working	Fair to good	Fair to excellent		Poor to fair	Poor to fair	Good to excellent
Behavior after 250 F and cooled (under working conditions)	Separates	No change		Liquifies	No change	No change
Principal uses:	Cup; pressure gun; general purpose industrial use.	Anti-friction; plain bearings; flat surfaces; for moderately high temperature lubrication.	Life lubricated bearings; specialed lubrication; for varying unusual demands.	Chassis fittings; oscillating bearings; where extreme tackiness or insolubility is needed.	Multi-purpose; all bearings; for general automotive lubrication.	Aircraft; multi-purpose, for superior performance under widely varying conditions.
Remarks:	Above 160 F these greases lose their water which is necessary to their stability, and separate into the original oil and a hard curdy soap. Below 160 F mechanized stability is good.	Good working performance at moderately high temperatures.	Vary widely with ingredient mixtures. Includes the very stable, oxidation inhibited greases used in "lifetime" lubricated bearings.	Very tacky, never fibrous. If heated above melting point, they may "set up" and then cool in that condition	Because of their high soap content, the fair multi-purpose greases may cause trouble in grease dispensing systems, in very high speed bearings, and in low temperature applications.	Have best available low temperature characteristics, and are good for high temperature applications. Much depends on formulation and combining of soaps and fatty acids. Certain lithium greases have the highest known mechanical stability.

Table I—Current Raw Materials Cost[1]

Material	Basis	Cost
Hot Rolled Low Carbon Steel Bar or Plate	1#	$0.048
Hot Rolled High Carbon Steel Bar or Plate	1#	0.052
Cold Rolled Low Carbon Steel Bar or Plate	1#	0.063
Cold Rolled High Carbon Steel Bar or Plate	1#	0.067
Hot Rolled Low Carbon Steel Sheet	1#	0.047
Hot Rolled High Carbon Steel Sheet	1#	0.055
Cold Rolled Low Carbon Steel Sheet	1#	0.055
Cold Rolled High Carbon Steel Sheet	1#	0.063
Hot Rolled Low Carbon Steel Strip	1#	0.055
Hot Rolled High Carbon Steel Strip	1#	0.057
Cold Rolled Low Carbon Steel Strip	1#	0.067
Cold Rolled High Carbon Steel Strip	1#	0.670
Structural Steel Angle	1#	0.045
Structural Steel Channel	1#	0.050
Structural Steel Plow Beam (I)	1#	0.055
Square Steel Tubing, Small	1#	0.045
Square Steel Tubing, Large	1#	0.085
Seamless Steel Tubing, Small	1 ft.	0.30
Seamless Steel Tubing, Medium	1 ft.	0.35
Seamless Steel Tubing, Large	1 ft.	1.30
Welded Steel Tubing, Small	1 ft.	0.23
Welded Steel Tubing, Medium	1 ft.	0.26
Welded Steel Tubing, Large	1 ft.	0.93
Standard Pipe, Small	1 ft.	0.08
Standard Pipe, Large	1 ft.	0.18
Extra Heavy Pipe, Small	1 ft.	0.10
Extra Heavy Pipe, Large	1 ft.	0.24
Wood	Bd. ft.	0.20

[1] Delivered, including freight charges

Table II—Operation Cost Averages

Operation	Small	Medium	Large
Cut-off or Block	$0.002	$0.004	$0.006
Shear or Trim	0.002	0.005	0.014
Saw Off	0.003	0.008	0.020
Lathe Cut-off	0.006	0.010	0.016
Blank	0.002	0.005	0.014
Punch or Pierce	0.002	0.010	0.022
Drill	0.007	0.015	0.040
Bore or Ream	0.005	0.080	0.200
Counterbore	0.005	0.007	0.010
Countersink	0.006	0.009	0.012
Spot Face	0.018	0.032	0.065
Tap	0.005	0.010	0.040
Thread	0.004	0.012	0.035
Bend	0.002	0.004	0.006
Form	0.002	0.006	0.018
Draw	0.006	0.012	0.025
Chamfer	0.006	0.013	0.027
Lathe Form	0.022	0.033	0.045
Face	0.010	0.028	0.045
Core	0.003	0.021	0.040
Mold or Cast	0.030	0.250	0.500
Forge	0.010	0.025	0.040
Mill	0.015	0.040	0.075
Grind	0.005	0.010	0.020
Case Harden	0.012	0.051	0.113
Weld Sub-Assembly	0.025	0.045	0.950
Bolt Sub-Assembly	0.018	0.150	0.400

A Simple Approach to

REX CLEVELAND
Design Engineer
Minneapolis-Moline Company

THE PROCESS of developing and designing a new product is a complex procedure. So many considerations are involved that the item of cost is apt to be forgotten. Function, performance, and sales appeal may overshadow cost. Yet, if the cost is too high to leave an adequate profit when the product is priced to meet competition, the whole purpose of the design is defeated.

The designer may rectify this if the error is discovered before production begins, but such a procedure is wasteful of engineering talent. If the design were to be guided by a careful consideration of costs in the process of its evolution, manufacturing economy would be automatically achieved and later trouble avoided.

Dollars and cents designing can be accomplished with the use of a few simple tables which can be compiled from the company records. All that is needed is a list of the material costs and a table of material weights. A good handbook will supply the latter.

These tables must be based on actual cost, not standard costs. and must be derived from production records on parts manufactured in the same plant. The purchasing department will supply the costs of all raw materials such as steel plate, bronze castings, wood, and tubing. Costs must be current costs, preferably based on invoices of recent shipments, and must include freight charges.

The recommended procedure then, is as follows:

1. Compile the information on raw materials cost into a chart as shown in Table I.

Table III—Price of Standard Fasteners

Item	Basis	Cost
Machine Screws, Small	Each	$0.003
Machine Screws, Large	"	0.023
Wood Screws, Small	"	0.005
Wood Screws, Large	"	0.045
Machine Bolts, Small, Sq. Head	"	0.004
Machine Bolts, Medium, Sq. Head	"	0.024
Machine Bolts, Large, Sq. Head	"	0.049
Cap Screws, Hex. Head, Small	"	0.006
Cap Screws, Hex Head, Medium	"	0.035
Cap Screws, Hex Head, Large	"	0.076
Carriage Bolts, Small	"	0.004
Carriage Bolts, Medium	"	0.022
Carriage Bolts, Large	"	0.047
Set Screws, Small	"	0.010
Set Screws, Large	"	0.057
Hex. Nuts, Semi-Finished, Small	"	0.003
Hex. Nuts, Semi-Finished, Medium	"	0.011
Hex. Nuts, Semi-Finished, Large	"	0.025
Flat Washers, Small	"	0.001
Flat Washers, Medium	"	0.004
Flat Washers, Large	"	0.019
Split Lockwasters, Small	"	0.001
Split Lockwashers, Medium	"	0.001
Split Lockwashers, Large	"	0.004
Shakeproof Lockwashers	"	0.004
Locknuts, Small	"	0.006
Locknuts, Medium	"	0.018
Locknuts, Large	"	0.040
Round Head Rivets, Small	"	0.004
Round Head Rivets, Medium	"	0.017
Round Head Rivets, Large	"	0.041

Table IV—Weights of Steel Plate

Thickness	Constant (C)
1/16	0.018
1/8	0.035
3/16	0.053
1/4	0.070
5/16	0.087
3/8	0.105
7/16	0.123
1/2	0.140
9/16	0.158
5/8	0.175
11/16	0.193
3/4	0.210
13/16	0.228
7/8	0.245
15/16	0.263
1 in.	0.280

Formula: Length x Width x Constant (C) = Weight in Pounds

Predetermining the manufacturing costs of products while still in the early stages of design is a problem common to all engineering departments. Here is an easy method that may be developed from the records of any company.

Cost Estimating

2. Select a list of typical parts that incorporate all the operations performed in the plant. Each operation should be represented at least 10 times. Submit this list to the Cost Department, requesting a breakdown of operation costs on each part.

3. Cull these costs and compile a chart similar to Table II, breaking them down into small, medium, and large parts. Total the individual operation costs for each size and average them. Use the averages in the chart.

4. Have the Purchasing Department supply current costs for a list of common sizes of typical fasteners used in the plant assemblies, and compile a chart similar to that in Table III. Divide these costs in size groups suited to customary requirements.

5. Obtain material weights, Table IV, which will be helpful in computing material costs. Any items not covered here can be obtained from a handbook.

These tables must be compiled in an easy-to-use form. Armed thus, the designer has an instrument that will enable him to keep his new product in line with cost requirements set up for it by the Sales Department.

It will surprise many designers to know what typical manufacturing operations cost. In a medium size plant, manufacturing heavy equipment on a moderate quantity basis, for instance, it costs an average of $0.004 to cut off a steel bar, $0.003 to bend the same piece, $0.011 to punch a hole, $0.018 to tap the same hole, and $0.009 to countersink it.

Use of such charts makes a comparison of methods easy. For instance, it costs about the same to core a rough hole in a casting as to drill it. Hence

there is no advantage to coring except to save cost of tooling. Yet, forging an average part costs only $0.045, against $0.293 for molding a grey iron casting, plus material.

The average bolted sub-assembly costs $0.189, while welded sub-assemblies run $0.475 each. Merely drilling a hole costs only $0.021, while reamings cost $0.095, an argument in favor of avoiding reamed holes.

Faced with a part such as that shown in Fig. 1, which for simplicity

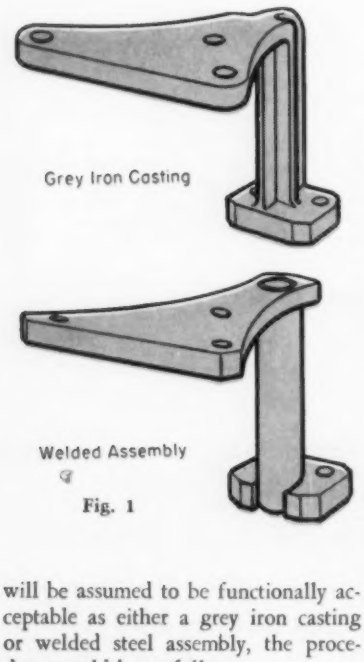


Fig. 1

will be assumed to be functionally acceptable as either a grey iron casting or welded steel assembly, the procedure would be as follows:

Reviewing materials, as a casting, it would weigh about 4 pounds. More section would have to be allowed than for steel. With grey iron running at about $0.10 per pound, the pig iron for the casting would cost $0.16.

Material	$0.400
Molding	$0.250
Drilling 5 holes at $0.150	$0.750
Countersinking 3 holes at $0.009	$0.027
Reaming 2 holes at $0.080	$0.160
Facing 2 surfaces at $0.045	$0.090
Total cost	$1.677

Making the same part from steel, would require 3 parts, plus welding. Two parts would be stampings, the other a rod. The large stamping would weigh two lb, at $0.048 per lb; total $0.096. The small stamping would weigh one lb, at $0.048. The rod would also weigh one lb, at $0.048. Costs for the welded assembly would be:

Steel for large stamping	$0.096
Steel for small stamping	$0.048
Steel for rod	$0.048
Blanking large stamping	$0.014
Blanking small stamping	$0.005
Punching 6 holes in both stampings	$0.132
Countersinking 4 holes	$0.048
Reaming 2 holes	$0.160
Cutting off 1 rod	$0.006
Chamfering 2 ends of rod	$0.026
Welding	$0.450
Total cost	$1.033

Comparing costs, the use of the welded steel assembly would seem to be indicated. If production were to be large, this would be true. However, tooling costs would favor the casting if production were to be small.

Use of these cost tables can become almost automatic. The designer can check himself as he proceeds with the design, and use the tables to help determine design and method simultaneously.

Building a Cost Manual

While some designers will find these tables sufficient for estimating product cost, others may go a step further and compile a complete Product Cost Manual. This manual can be used with extreme accuracy, if it is kept up to date, and can be easily developed from the material in any plant.

The best method to use in formulating this data is as follows:

1. List all types of parts used on all the products manufactured in the plant, thus:

Grey Iron Castings	Steel Forgings
Malleable Iron Castings	Steel Shearings
Steel Castings	Steel Stampings
Bronze or Brass Castings	Steel Turnings
Brass Stampings	Molded Plastic
Brass Turnings	Wood Turnings
Die Castings	

More categories will be necessary, of course, depending upon the types of products manufactured. Hardware must be listed, as well. Modified hardware should be listed separately.

2. Break down each type of part; for instance, with grey iron castings:

Simple, Raw, No Cores
Simple, Raw, Cored
Simple, No Cores, Minimum Machining
Simple, Cored, Minimum Machining
Simple, No Cores, Medium Machining
Simple, Cored, Medium Machining
Simple, No Cores, Maximum Machining
Simple, Cored, Maximum Machining, etc.

The same list might apply to grey iron, malleable iron, steel, brass, bronze or aluminum castings, with only the costs differing. Some designers might like to break it down still further. An additional classification for castings of "average" complexity might be desirable. Or it might be expedient in some cases to classify according to number, or types of machine operations, such as milling, planing, drilling, tapping, and boring. It would even be possible to classify according to the numbers of each type of operation. The further this is carried, the more accurate the manual becomes.

3. Select a picture of a part made in the plant which is truly representative of each of the parts described in the parts classification breakdown. These pictures may be either parts drawings, sketches, or photos. All pictures should be 8½ x 11 in. in size. Use "A" size detail drawings where possible. Reduce all larger drawings to this size, or re-sketch on letterhead size paper or "A" size detail sheets. The lists are only a guide or outline for the compilation of the manual of pictures. Label each picture with its proper classification title, such as: "Casting, steel, large, minimum machining", or: "Stamping, brass, small, blank and form".

4. Next, list the cost of each of the parts on its picture. This can be done on an average quantity basis, or it can be listed for small, medium, and large quantities, or specific quantities, according to requirements.

5. Bind the pictures into a ring binder, or several ring binders if required, and arrange alphabetically, according to classification, and progressively, according to classification breakdown. It might begin with: Casting, brass, simple, raw, no cores, and continue.

The more complete the manual, the more complete the coverage. The degree of accuracy depends upon accuracy of cost figures and the extent of classification breakdown. The cost figures must be the most accurate obtainable. They must not be derived from "standard" costs, but from "actual"

manufacturing costs based upon the purchase price of material obtained from invoices. Time studies should be made of all labor involved in manufacturing, and freight charges on material and purchased parts should be added. The cost figures also should include such items as: applicable overhead; handling; and storage.

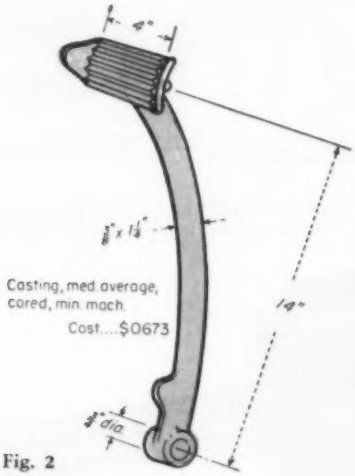


Fig. 2

Suppose the part being designed is a brake pedal, (Fig. 2). It is first necessary to determine whether the part should be cast, forged, or fabricated of welded stampings, and what the strength requirements are. The part is simple in design, with one bored hole for the brake-shaft, and one hole for a spring hook which in this case could be cored in a casting, drilled in a forging, or punched in a stamping.

Reference to castings classified as: Medium, simple, cored, minimum machining, should give an idea of cost. Looking under forgings, simple, medium, minimum machining, would give a comparison, as would reference to Welded Assemblies, medium, simple. Comparison of these costs, together with the relative strength and weight, or appearance factors, would determine which to use.

Where the problem is the determination of cost for a projected product, reference to parts of the layout, and totalling of costs will give the complete picture. It is only necessary to bring the design to a point where a fair picture of each part can be obtained. Use of the manual will do the rest.

Purchased parts must be listed separately, and illustrations are not always necessary. Lists and specifications are sufficient for most fasteners such as nuts, bolts, screws, washers, ferrules, rivets, and pins. Special purchased parts may be listed and pictured provided they fit a pattern.

These would include such items as: motors, lights, cables, handles, knobs, wiring harnesses, and the like. Other special purchased parts must be submitted to the Purchasing Department for pricing.

If such a manual is to pay divdends, it must be compiled from the records of each individual firm, and kept up on a current basis, with periodic revisions. It takes very little time to select the representative drawings or pictures, dig out the costs, and combine them into compact manual form for everyone to use. The ease and accuracy with which the cost of projected product designs may be estimated makes the time and effort well spent.

NBS Studies High Pressure Pneumatics

MANY AERONAUTICAL ENGINEERS have cast a longing eye at high pressure pneumatic equipment because it looks like a way to save space and weight in control circuits, particularly those regulating high speed operations (*Product Engineering*, January 1953, p. 199). But there's been one major obstacle: lack of authoritative data.

At the request of the U. S. Navy's Bureau of Aeronautics, the National Bureau of Standards has inaugurated a comprehensive program designed to research and evaluate this subject. Although the emphasis will be placed on military aircraft applications, Bureau scientists feel that there will be much valuable information unearthed for the aircraft industry as a whole and other fields that use high pressure technology.

NBS has started research basic to the design and evaluation of compressors, storage tanks, accumulators, valves and other equipment.

Heart of the program will be finding answers to two problems: 1) determination of the factors governing the most efficient storage and working pressure; and 2) determination of the pressure losses in pneumatic systems during transient flow.

Preliminary calculations have already indicated that storage pressures of 3,000 psi are justified. Apparently higher pressures might yield further savings in weight and space, but with diminishing returns.

To solve the number two problem, NBS scientists first have to evaluate pneumatic losses under steady flow conditions. They will then try to correlate such losses with those occurring under transient flow.

Navy specialists hope that this program will give NBS a chance to improve current testing procedures for pneumatic components. They feel that some practices are inadequate; some of today's definitions are ambiguous. The Bureau is examining the bases on which existing tests have been set up.

Typical example: evaluating component characteristics. Previously, flow characteristics of a component were described by a family of curves—plots of flow rate versus downstream pressure for various values of upstream pressure—that required numerous careful measurements to obtain the necessary data. NBS has evolved a method for describing the pressure drop across any pneumatic component in terms of a single characteristic curve. Their answer is to plot the ratio of downstream pressure to upstream pressure against the ratio of flow-rate to upstream pressure, producing a curve unique for each component tested.

The new approach led to the Bureau's defining a new term "flow factor". The flow rate where the pressure is ½, this term is constant for a particular component. Once determined, it can be used to predict upstream conditions.

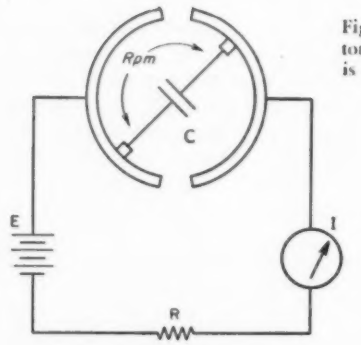


Fig. 1 — Basic schematic circuit for commutation-capacitor speed measurement systems. Polarity of the capacitor is reversed twice each revolution by a commutator.

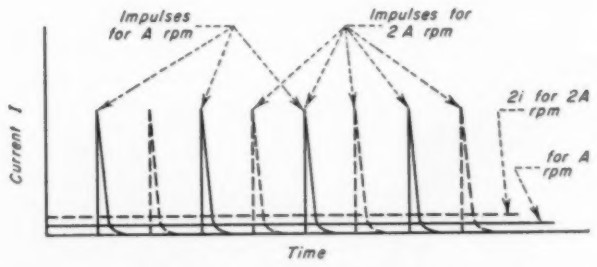


Fig 2—Current-time relationship. Average current value *i* is linearly proportional to speed.

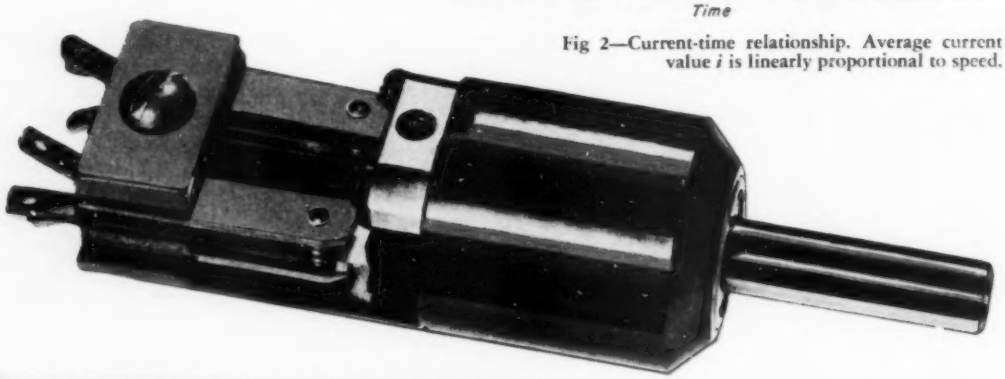


Fig. 3—Head element, which is a double-pole, double-throw switch, is actuated by rotation and performs the function of the commutator in the first figure. Speed range governs cycles.

Capacitor Commutator Tachometers

Types of capacitor commutator systems for speed measurement and control, including the principles of operation, basic circuitry, and relative advantages of each.

F. K. FLOYD
President

D. J. CODY
Eastern District Mgr.
Metron Instrument Co.

THE CAPACITOR COMMUTATOR SYSTEM of speed measurement has, in the past few years, been applied not only to hand tachometers but also to fixed installation tachometers, recording tachometers, speed controls, and super accuracy tachometers.

These tachometers employ one ramification or another of the basic circuit shown in Fig. 1. In this circuit a constant voltage source *E* is connected in series with a capacitor *C* and a milliammeter *I* having resistance

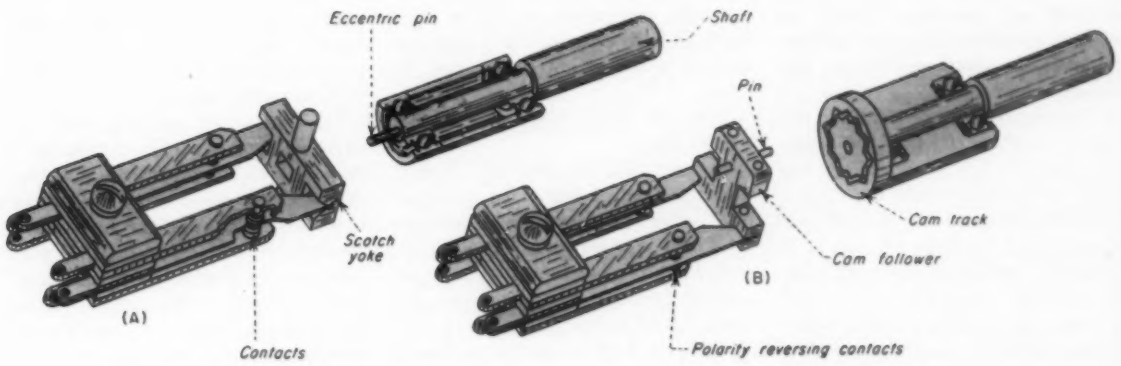


Fig. 4—How the head elements function: (A) eccentric pin moves scotch yoke to make and break contacts and provide one switching cycle per revolution; and (B) cam follower actuated by cam track moves contacts through two, five, or ten reversal per revolution, depending on the number of flutes in the cam, which depends on speed.

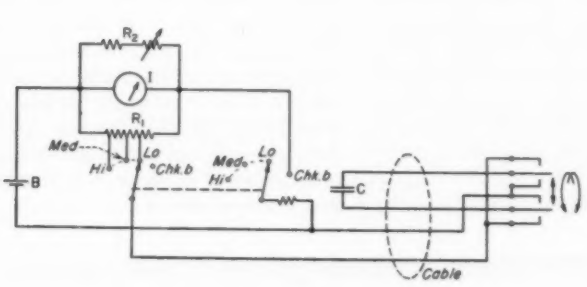


Fig. 5—Hand tachometer and electrical circuit. Resistance R_2 is used to compensate for differences in voltage supply from the flashlight battery. The check "b" positions on the switch are used during this calibration. Three ranges of speed indication are obtained by the high, medium, and low taps on resistance R_1.

R. The polarity of the capacitor is reversed by a commutator twice each revolution with a frequency proportional to the speed being measured.

The values of C and R are so chosen with respect to the maximum rpm to be measured that the capacitor is charged to the full value of E long before its polarity is again reversed. The current-time relationships, Fig. 2, show that typical capacitor-resistance discharge impulses occur at a rate proportional to the speed.

Inertia of the d-c milliammeter provides a steady indication i which is the average of the individual current impulses caused by speed A. If the speed is doubled to $2A$ then twice as many impulses occur producing twice the reading or $2i$. Thus, the relationship of average current or reading is proportional to speed as follows:

$$I = \frac{C \times E \times rpm}{15}$$

For all practical purposes, the above equation is exact and brings to light several things.

1. Current is proportional to speed. What little nonlinear error occurs between actual speed and readings is due to nonlinearity of the milliammeter employed. Thus, nonlinearity exists only between current and indicator reading and not between speed and current.

2. Since linear relationship exists, it is feasible to have a single, linear scale distribution for all single speed ranges or for multiple speed ranges, which can be obtained by the use of simple milliammeter shunts.

3. The combination of the rotating capacitor and commutator can be considered as a resistance component whose value varies inversely with the speed being measured. This consideration permits extension of the system to more complex circuits such as bridges to obtain high accuracies of speed measurements.

4. The equation does not contain the factor R, which means that current values are unaffected by the resistance of the circuit. This is true as long as total resistance is below a certain value —in most instances, several hundred

ohms. Thus the resistance of a long or short cable between indicator and tachometer head has no effect on calibration or accuracy. Neither do indicators connected in series disturb calibration or affect accuracy of the speed indication.

5. Current I is dependent on the value of voltage E and the value of capacitor C. Therefore, it is necessary to keep voltage and the capacitance constant. In the case of the voltage, this is done in practice by a calibration circuit or an automatic voltage regulator. (See Figs. 5, 6, and 7.) Capacitance value is held constant by proper selection of stable capacitors.

Tachometer Head Elements

From the foregoing, it is seen that this system of speed measurement is in no sense a generator type of instrument. For this reason, it is not possible to interchange these indicators or heads with indicators or generators of other types of tachometers.

In actual practice, the speed sensing element coupled to the speed being measured is merely a double-pole, double-throw switch actuated by rotation. The switch, or head element, Fig. 3, specially developed for the purpose, performs the function of the commutator in Fig. 1.

It is made in several types having 1, 2, 5, or 10 complete switching cycles per revolution in order to provide suitable impulse rates when the heads are coupled to various broad ranges of speed.

In the type shown in Fig. 4 (A) one head element provides one complete switching cycle per revolution, i.e., two polarity reversals. This unit consists of an eccentric pin machined on a shaft that moves a scotch yoke sinesoidially up and down to actuate the polarity reversing contacts. This is a high speed element and is coupled to speeds between 2,000 and 10,000 rpm for full scale deflection of the indicator.

In Fig. 4 (B) is one of several head element types that provide up to 10 switching cycles per revolution and are for coupling to speeds ranging from 200 to 5,000 rpm for full scale reading. In this type, the shaft carries a cam track having 2, 5, or 10 flutes into which a pin projects to actuate a cam follower and polarity reversing contacts. The cam track is generated to give a sine wave motion to the moving contacts.

In both of these basic types of head elements, the switch is driven positively in both directions and does not depend upon spring action for its return.

The basic head elements are so designed that:

1. Long life is obtained. Actual tests have shown life to be in excess of 2 billion switching cycles without maintenance or loss of accuracy.

2. Friction losses and inertia of moving parts are low, permitting: accurate speed readings on low power devices; the head element to be geared up to as much as 100 to 1 for steady speed readings as low as 1 rpm and less; the head element to be geared down so that speed readings up to 100,000 rpm can be made with a practical amount of power consumed; accurate readings and low torque requirements during periods of acceleration.

3. The small size of the head element makes possible small tachometer head designs and a resulting lightweight construction.

4. Since the head element is merely a switch, all heads of the same type are interchangeable and do not have individual voltage characteristics. This permits use of several tachometer heads, selectable by a rotary switch to monitor speeds of several machines with a single indicator.

5. Direction of rotation does not affect indicator readings. Referring to Figs. 1 and 2, the limiting factors that determine the speed range of any one head element are: the maximum speed at which the contacts will operate with sufficient dwell time to permit complete charging of the capacitor; and the minimum number of impulses per minute that the milliammeter can average out to obtain steady readings.

Ordinarily head element types and gear ratios (in geared types of heads) are called for so that the contacts operate in ranges between 2,000 and 10,000 switching cycles per min for full scale indicator reading. This means that a multiple range indicator, when used with a single tachometer head, is capable of measuring speeds down to 1/50 of maximum reading, on the basis of readings to 1/10 scale on the lowest range.

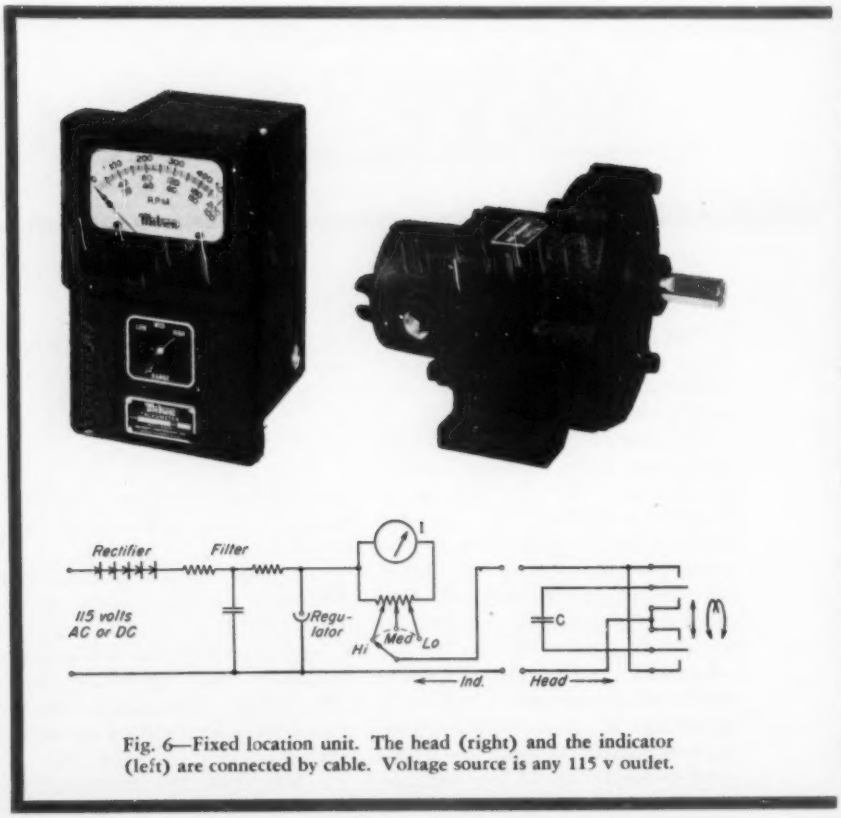


Fig. 6—Fixed location unit. The head (right) and the indicator (left) are connected by cable. Voltage source is any 115 v outlet.

Hand Tachometers

The hand tachometer, Fig. 5, uses the basic circuit of Fig. 1 but in more detail. The voltage source is a single flashlight battery B contained in the handle of the indicator. The capacitor, also located in the indicator case, is designed to have high stability with age and with temperature changes. The indicator movement has relatively high inertia to minimize current impulse effects at low speed readings. Three ranges are obtained by shunt resistor R_1, and the selector switch. The "check B" position of the switch provides a calibration circuit in which R_2 is adjusted to obtain a fixed reading on the indicator scale. This adjustment permits compensating for any changes that occur in battery voltage, shunting resistors, or meter sensitivity. The range of R_2 is limited so that when the calibration reading can no longer be obtained, a new battery is required. Battery life is in the order of 1 to 2 years with the usage that a hand tachometer ordinarily gets.

The above design permits the production of several three-range hand tachometers, each having three different total ranges. Various models differ only in the scale markings and in the basic head element, which provides either 1, 2 or 10 switching cycles per revolution of the head shaft.

Fixed Installation Tachometers

A typical indicator and tachometer head for fixed installation, Fig. 6, operates on a constant d-c voltage that is obtained from a rectifier, filter and automatic voltage regulator and a 115 v supply. In most cases the capacitor is mounted in the tachometer head so that only two wires connect from the indicator to the head. Cable length or size does not affect calibration.

The tachometer head shown is a geared type for low speed measurements under rugged conditions. Likewise, indicators other than the one shown can be used. These include single range types for use when a small measuring range is sufficient, and multiple head types for monitoring speeds of many machines. Contact making indicators, and recorders are also available using the same basic speed measuring system.

Since all of the components of these instruments have long life, fixed installation units normally are operated continuously. Speed ranges are precalibrated by means of fixed resistors which are accessible through the rear terminal compartment.

High Accuracy Tachometers

All tachometers discussed up to this point have a specified accuracy of 1.0 percent of full scale.

However, referring to Fig. 7, fixed installation and portable tachometers are available having accuracies to $\frac{1}{4}$ percent of the speed being measured. This is made possible by a bridge circuit.

Here the combination of the capacitor C and the polarity reversing head switch are connected in one leg of the bridge circuit so that the degree of balance of the bridge and the current I is determined by the speed being measured; speed is directly indicated on the scale. The scale does not read to zero speed but spreads out all ranges so that the minimum reading (bridge balance point) is three fourths the full scale value. There are 10 adjoining or overlapping ranges selected by a switch that connects in 10 different values of capacitance C.

The calibration circuit consists of standardizing resistors R_1 and R_2, variable resistors R_3 and R_4, and switch S_1. Calibration is performed by switching R_1 into the bridge leg and adjusting R_3 for correct bridge balance, then switching R_2 into the bridge leg and adjusting R_4 for bridge sensitivity. This procedure compensates for changes due to age, temperature, or voltage variations that might occur in power supply, indicating meter, or bridge components. Switch S_1 is then set to the "read" position, which introduces capacitance C and the polarity reversing head switch into the bridge.

This system requires only that the mica capacitors, standardizing resistors, and scale distribution of the indicator remain constant to insure high accuracy. These tachometers may be used with a head cable up to about 10 feet without a sacrifice in accuracy. If a longer cable length is used, change in capacitance of the cable due to temperature changes begins to show up, in effect changing the value of C.

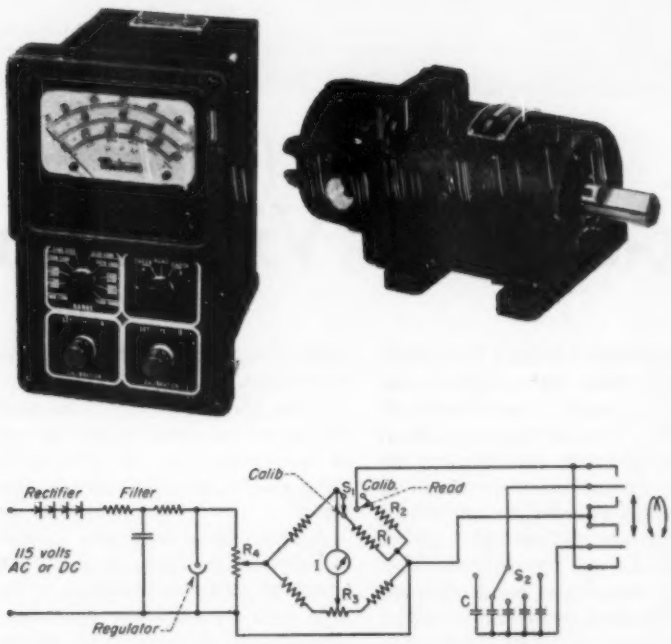
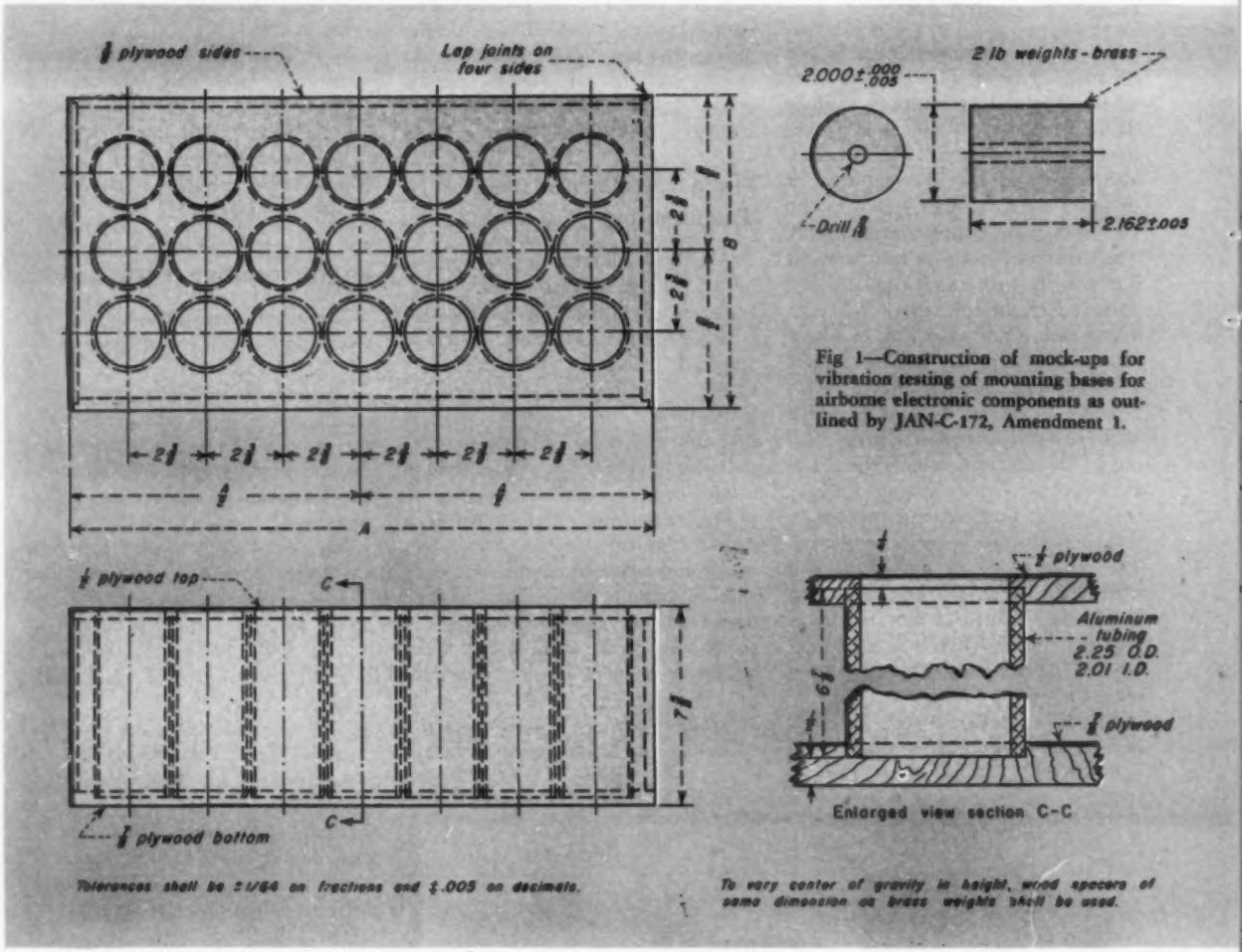


Fig. 7—High accuracy tachometer, and bridge circuit that makes possible indication to within $\frac{1}{4}$ percent of speed being measured.


¾ plywood sides
Lap joints on four sides
2.000 +.000 -.005
2 lb weights - brass
Drill ⅛
2.162±.005
Fig 1—Construction of mock-ups for vibration testing of mounting bases for airborne electronic components as outlined by JAN-C-172, Amendment 1.
¾ plywood top
¾ plywood bottom
¾ plywood
Aluminum tubing 2.25 O.D. 2.01 I.D.
Enlarged view section C-C
Tolerances shall be 1/64 on fractions and ±.005 on decimals.
To vary center of gravity in height, wood spacers of same dimension as brass weights shall be used.

Mock-ups for Vibration

MOCK-UPS USED IN VIBRATION and shock tests are far more difficult to design than the paper, plastic, or wood models whose prime function is to look like operating equipment. These must act like the equipment they simulate, or the tests may be completely worthless. In fact, if the dynamic properties of the mock-up do not correspond to those of the actual equipment, the test data, though correct for the test conditions, may be in direct opposition to what occurs in service.

This is particularly true for vibration and shock tests on mounting bases for airborne electronic components and instruments. Ideally, a base should be tested with the equipment for which it is intended, but often this is impossible. The component may be in the prototype stage and therefore not available for testing, or the mounting base may be intended for several instruments of similar size and shape but different dynamic properties. Also, economy may dictate using mock-ups when the actual equipment is expensive and easy to damage during test.

The requirements for an ideal mock-up for vibration testing of these mounting bases can be outlined as:

1. Same weight and moments of inertia about all axes as the equipment it simulates.

2. Be attached in exactly the same manner as the actual equipment and be interchangeable with this equipment insofar as attachment is concerned.

3. Have an arrangement of mass and elasticity as similar to that of the actual component as possible.

In most instances, the weight and center-of-gravity location are known but moments of inertia are neither known nor readily calculated. Thus, a standard procedure is to build a mock-up with a box-like structure hav-

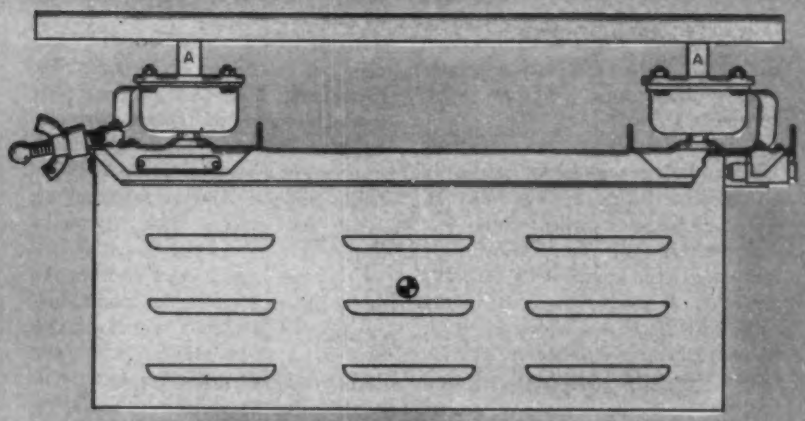
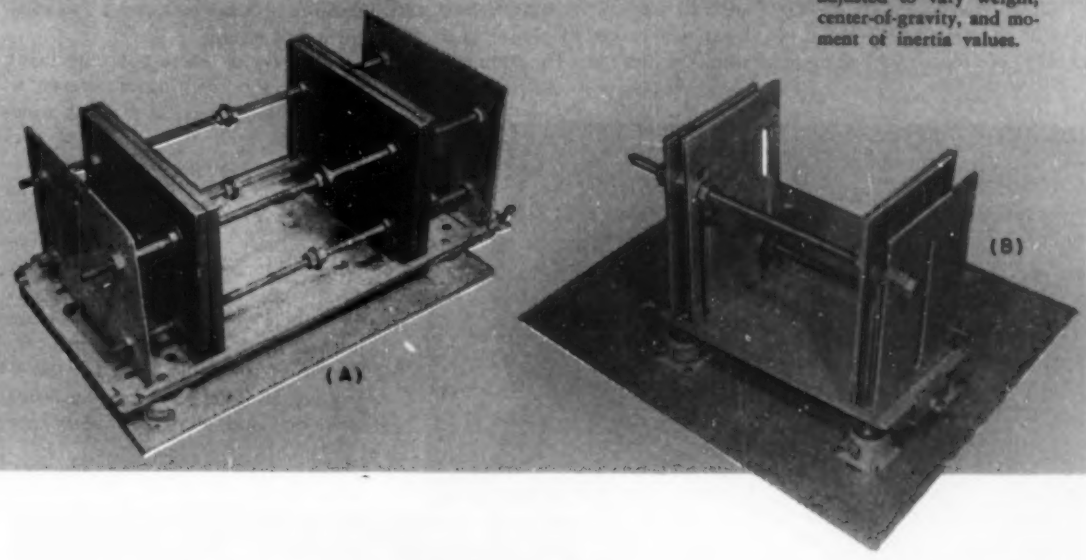


Fig 3—Set-up for shock testing a mounting base in the inverted position. Strain gages are located at points marked *A* on the two supporting rods.

Fig 2—(A) and (B) Metal mock-ups for vibration testing of components with uniform weight distribution. Slotted plates can be added, removed, or adjusted to vary weight, center-of-gravity, and moment of inertia values.



and Shock Testing

CHARLES E. CREDE
Chief Engineer, The Barry Corporation

ing the same general size as the actual equipment, but with completely regular outlines. The weight and center-of-gravity location are the same as on the original equipment, and the density is assumed to be constant throughout the equipment.

Since the forces applied in vibration testing alone are relatively small, the strength of the mock-up is not critical. A construction of the type described in Government Specification JAN-C-172, Amendment 1, is generally strong enough. As shown in Fig. 1, this specification calls for a wooden box having sockets in which the added weights are placed. These weights are held in the sockets by gravity only. The disadvantage of this construction, besides the loose weights, is that it is not convenient to make independent adjustments of weight, center-of-gravity, and moments of inertia.

Thus, for vibration testing where the application can be satisfied by a mock-up of uniform density, a metal framework such as illustrated in Fig. 2 may be prefered to that of Fig. 1. The added weights are in the form of slotted plates which can be added or removed readily, or adjusted lengthwise in the mock-up. It is, therefore, a simple matter to change the weight as well as to adjust the location of the center-of-gravity and the value of the moment of inertia along the lengthwise axis.

These mock-ups are not satisfactory, however, for shock testing or vibration testing in which a non-uniform weight distribution is required. In shock testing two additional requirements must be added to the three listed previously for vibration mock-ups:

1. Must have strength at least adequate to withstand the tests.

2. Should reinforce the base to the same extent as the actual equip-

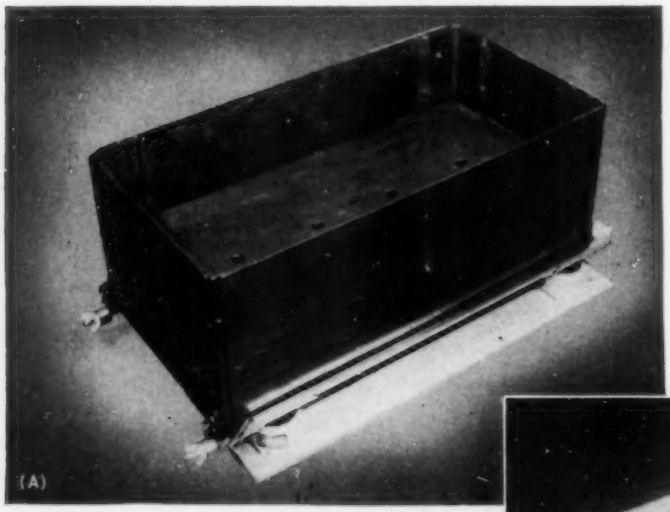
ment or component will reinforce it.

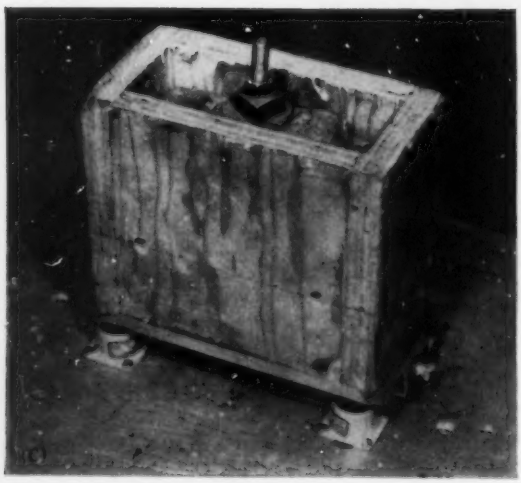
The latter condition represents perhaps the greatest problem in designing mock-ups for shock testing. It can be illustrated by Fig. 3. This shows an arrangement for shock testing a mounting base in the inverted position. The design is such that the front isolators, adjacent to the thumb nuts, carry a greater static load than the rear isolators because the center-of-gravity of the equipment is at its geometrical center as shown. To investigate the loads on the respective isolators, SR-4 strain gages were applied at positions *A* on the supporting rods. Tests gave the unexpected result that the maximum loads on the rear isolators were greater than those on the front isolators. Upon investigation, it was learned that the tray had yielded in the vicinity of the front isolators. Certain types of mock-ups may tend to reinforce the tray to a greater extent than does the actual equipment. The reinforced tray may thus not yield in the vicinity of the front isolators, and they would then carry a greater share of the dynamic load than would be true in service.

Furthermore, the individual parts of a piece of equipment do not necessarily act together during a shock test. In fact, the opposite is usually true. For example, the individual elements of many electronic components resemble cantilever beams with concentrated end-loads. If the test is one in which the equipment is attached to a freely falling elevator, and if the natural frequencies of the various cantilevers are different, the motions of their end loads will be out of phase before the vibration dies out. The summation of the maximum inertia forces of the loads is less than the inertia force from a single load of equal mass falling the same distance.

In effect then, many types of equipment can be considered as assemblies of numerous masses and springs, each of which behaves in its own characteristic manner when subjected to shock. From an ideal viewpoint, the mock-up should duplicate this arrangement of masses and springs. This is usually unattainable in practice, not only because of the great amount of work required in constructing the model, but also because the exact nature of the mass and spring combination is very obscure in most cases. In fact, it is common practice to ignore this factor completely when designing mock-ups for shock testing.

Some typical mock-ups now being used for shock testing are shown in Fig. 4. Both wood and metal structures are used with lead or steel weights bolted to the structure to produce the desired characteristics. The weights must be added with considerable care so as not to produce unrealistic moments of inertia which may result if the weights are added indiscriminately. These illustrations are not presented as ideals—rather as examples to stress the need for standardized, well-designed mock-ups for vibration and shock-test purposes.





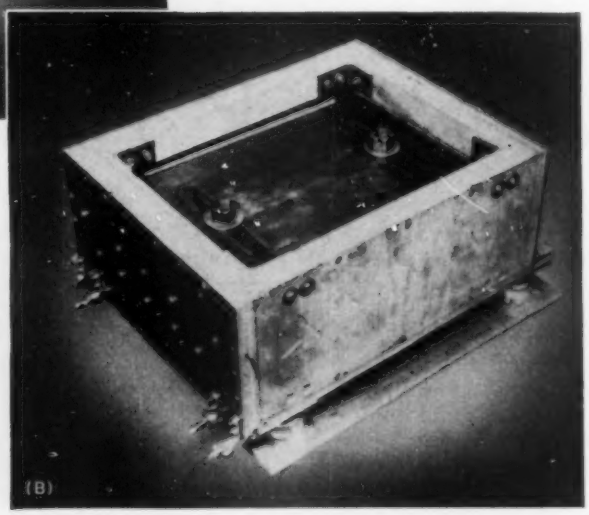


Fig 4—Typical mock-ups now being used for shock testing were designed to endure several series of tests. Weights are bolted to the structure to produce the desired characteristics.

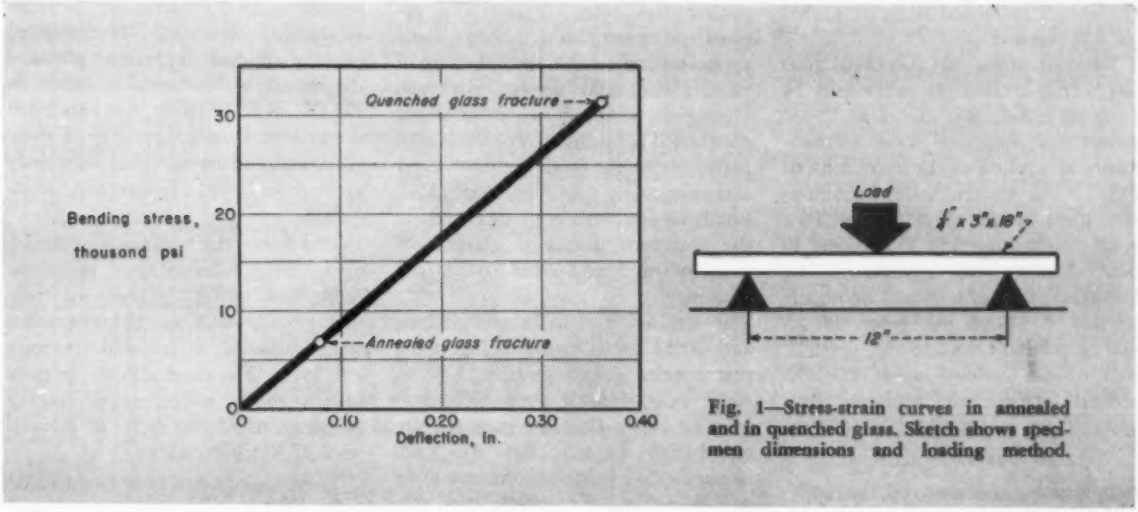


Fig. 1—Stress-strain curves in annealed and in quenched glass. Sketch shows specimen dimensions and loading method.

Residual Compressive Stress Strengthens Brittle Materials

Effect of retained residual compressive stress on the ductility of the surface layer of brittle materials in reducing applied surface tensile stress. Spring test data demonstrate the beneficial effect of residual compressive stress in the surface of hard steel.

JOHN O. ALMEN
Research Consultant

UNDER CONDITIONS of brittle fracture, specimen surfaces are weaker than sound subsurface material. When such relatively weak surfaces are residually stressed in compression, the specimens will support greater tensile loads and will exhibit greater ductility because the applied surface tensile stress is reduced by an amount equal to the retained residual compressive stress.

The strengthening effect of residual compressive stress in brittle materials is perhaps most easily demonstrated with glass specimens. Among the advantages of glass for evaluating residual stresses is that at ordinary temperatures glass is completely brittle. For this reason, the residual stress pattern remains unaltered by plastic flow to the instant of fracture. Also, any apparent unorthodox behavior of glass will not mistakenly be attributed to cold work or altered structure.

Residual compressive stress in glass surfaces is developed by rapid cooling, usually by air jets, from some elevated temperature at which glass is plastic. The surface of the glass in cooling contracts, thereby plastically deforming the still hot and ductile subsurface glass. As cooling continues, the subsurface glass contracts against the relatively cool and rigid surfaces, resulting in residual tensile stress in the core and corresponding residual compressive stress in the surface.

The relative static strength of a specimen of normal glass, which was carefully annealed to avoid residual stresses, and that of a similar glass specimen that had been quenched on both surfaces as described in the preceding paragraph is shown in Fig. 1. As shown by the insert in Fig. 1, these specimens were ordinary ¼ in. plate glass, 3 in. wide and 18 in. long. Each was placed on supports spaced 12 in. apart, then downward acting loads were applied at the mid-points. It is seen that the annealed glass failed at 7,000 psi calculated stress, and that the residually stressed glass did not

fail until a calculated stress of 32,000 psi was reached.

Residual stress in quenched glass has been measured photoelastically by Littleton (Ref. 3). In Fig. 2 are shown the results of these measurements as applied to the specimens of Fig. 1. The surface residual compressive stress of the quenched specimen is seen to approximate 25,000 psi. In beam loading, the surfaces of the quenched specimen were nominally stressed to 32,000 psi. Since the actual or resultant stress is the algebraic sum of the residual stress and the nominal stress, the resultant stress ranges from

$$32{,}000 + 25{,}000 = 57{,}000 \text{ psi}$$

compression, as shown on the upper surface of the diagram Fig. 2, to

$$32{,}000 - 25{,}000 = 7{,}000 \text{ psi}$$

tension, as shown on the lower surface of the diagram Fig. 2, with a maximum subsurface tensile stress of 21,000 psi.

Thus it is seen that the quenched glass specimen failed at the same resultant tension surface stress as the annealed glass specimen, but the former supported a load four times as great as the latter. This increase in load carrying capacity was possible because brittle materials fail only by tension and subsurface tensile strength is greater than surface tensile strength.

The advantages of prestressed glass have been known and the quenching process has been commercially applied for upward of a century. Early applications were the strengthening of wine glasses and similar glassware. During the kerosene age, extra strong prestressed lamp chimneys commanded premium prices. Today almost every automobile uses quenched glass. Also, extensive use of such glass is seen in the numerous unframed glass doors used in stores and other commercial buildings.

Prestressed steel has also seen long and varied use in many machine parts that require extremely hard steel to resist wear, but in which brittleness must be avoided because the parts are also highly stressed, (Ref. 4). Such demands have been and continue to be met by processing to obtain hard surfaces and "tough" cores, that is, by case hardening. The hard case, whether obtained by carburizing, nitriding, or cyaniding, would be just as brittle as through hardened steel of the same hardness except for the fact that, when properly applied, the hard cases resulting from these processes are, like quenched glass, residually stressed in compression. Incidentally, the core in such specimens is "tough" only because, being submerged, it is not afflicted with surface weakness.

Shot peening, which produces residual compressive stress in the peened surfaces, is more effective in reducing brittle fractures when applied to hard brittle steel than to soft ductile steel because surface vulnerability increases as ductility decreases. The beneficial effect of residual compressive stress in the surface of hard steel is shown in Fig. 3. In these charts, the bars show the relative fatigue durability of three groups of coil springs that differ only in hardness and prestressing treatments.

The lower chart shows a summary of the fatigue durability of thirty-two production springs in terms of their average life, which was 157,000 cycles, when subjected to repeated compressive loads. The chart also shows their life variability, which ranged from a minimum of 45,000 cycles to a maximum of 355,000 cycles.

These springs had been heat-treated to Rockwell C52-53 hardness followed by preset, that is, the springs were compressed to solid height at 575 F. This operation caused plastic yielding in the most highly stressed regions, thereby reducing the maximum stress under subsequent loads. They were then shot peened at an intensity of 0.017A2 and again preset, this time at room temperature.

To measure the effect of high hardness on fatigue durability, four springs commercially identical with the thirty-two production springs were prepared as indicated in the upper bar charts of Fig. 3. These experimental springs were quenched from the same temperature and in the same medium as the production springs but the tempering treatment was omitted. Their hardness was Rockwell C61-63. Two of the four springs were then shot peened at an intensity of 0.026A2. This intensity was higher than that used in peening the production springs because the hardness of the metal to be peened was higher, and the peening treatment preceded presetting because of the possibility of damaging (Ref. 5) the hard unpeened steel by presetting. To avoid loss of hardness, the four springs were finally preset at 300 F instead of 575 F used on the production springs.

When fatigue tested under the same loads that were applied to the production springs, the non-peened hard springs failed in less than 10,000 cyles, whereas the minimum life of the shot peened hard springs exceeded the maximum life of the production springs. More significant, because of the small number of hard specimens tested, is their greater maximum life.

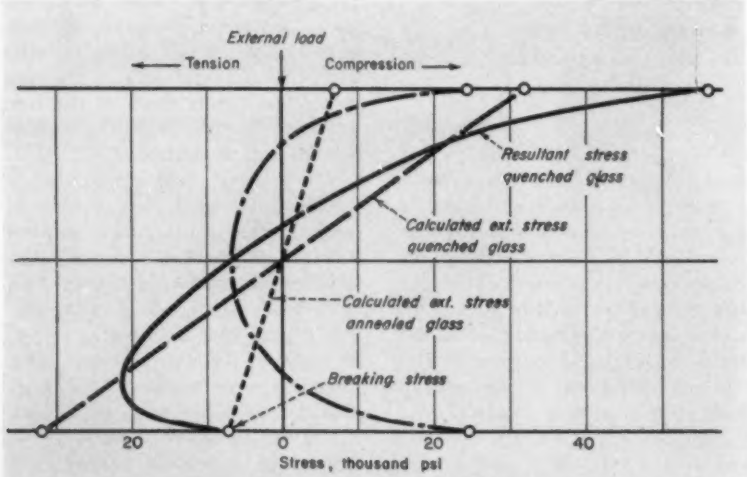


Fig. 2—Reconstructed diagrams to show stress distribution in glass beam specimens when they were loaded to failure.

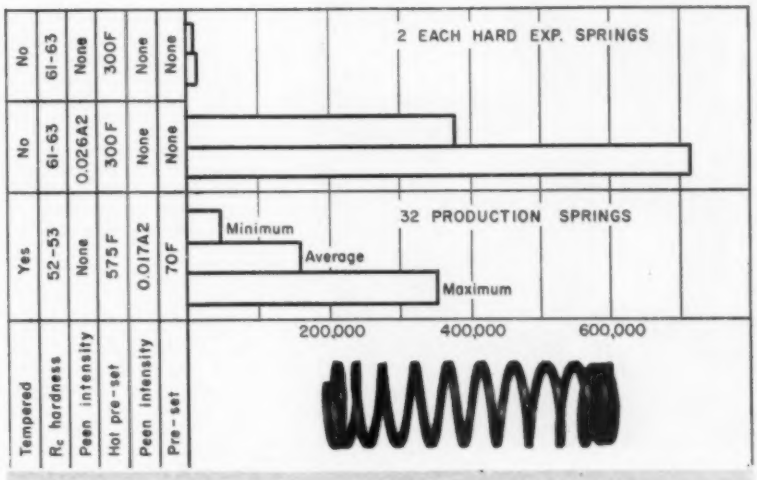


Fig. 3—Relative fatigue durability of groups of coil springs that differ only in hardness and prestressing treatments.

This increase in fatigue durability cannot be attributed to work hardening because the hardness of very hard steel is not increased by shot peening.

The greater intrinsic strength of the harder steel could not be realized in the non-peened springs because of surface weakness. But when the surface tensile stress was reduced by the residual compressive stress that was induced by peening, some of the greater subsurface strength became available. It is possible that had these hard springs been strain peened to increase the magnitude of the residual compressive stress (Ref. 2), even greater fatigue durability would have resulted.

The tests on these production and experimental springs were made during World War II by the Spring Division, Eaton Manufacturing Company, as part of a cooperative research program that included the Research Laboratories Division, General Motors Corporation.

Similar effects may be expected from any other process, including stretching, that protects the surface with a layer of compressively stressed metal. Conversely, processes that develop residual tensile stress in steel surfaces increase brittleness.

Several thermal and mechanical processes, other than those mentioned in the preceding paragraphs are known to induce residual compressive stresses in steel surfaces. Additional thermal processes are drastic quenching of low hardenability steel, steel quenched from tempering temperatures higher than 800 F, induction hardening, and flame hardening. Among additional mechanical processes are superficial rolling, honing, tumbling, several machining operations, and certain cold forming and straightening production operations.

Processes that increase brittleness by inducing residual tensile stress in steel surfaces are welding, flame cutting, grinding, and probably the opposite of stretching, that is, axial compressive loading sufficient to cause permanent deformation. Most of the currently used cold straightening and cold forming processes reduce brittle strength and ductility of steel because they induce residual tensile stress in the surface metal.

Because of the enhanced ductility and strength of potentially brittle metals processed to develop surface residual compressive stress, such treatments should be applied to all hard machine parts, especially when used at low temperatures. Since the damaging effects of surface residual tensile stress are increased at low temperatures, processes that induce such stresses should be avoided.

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NEW NON-GALLING STAINLESS

A NEW STAINLESS STEEL ALLOY, V2B, that won't gall or seize in corrosive service has been developed by The Cooper Alloy Foundry Co. Containing copper (2.0-2.25 percent), molybdenum (3.0-3.5), silicon (2.75-3.25), chromium (19.0-19.5) and small amounts of beryllium (0.10-0.20), the alloy is a hardenable 18-8 type of stainless.

Low temperature heat treatment hardens V2B without distortion and with only a light tinting discoloration. In the quench annealed state, the alloy is readily machinable; in the annealed state, it is readily welded with special V2B rod. Cooper claims that their new stainless will not overage at elevated temperatures, like other precipitation hardenable alloys. That makes it possible to use V2B in steam applications and at temperatures up to 1400 F.

In the hardened condition, resistance to sulfuric, hydrochloric, and phosphoric acids, and their salts exceeds that of all precipitation hardenable alloys. In nitric acid it is not quite the equal of types 304 or 316 stainless.

Cooper supplies the new alloy in both cast and wrought form. As cast, its hardness is 302 Brinnel; quench annealed, 269; and annealed and hardened, 363. Other characteristics: tensile strength, 151,000 psi; yield strength, 122,400 psi; elongation, three percent; reduction of area, two percent.

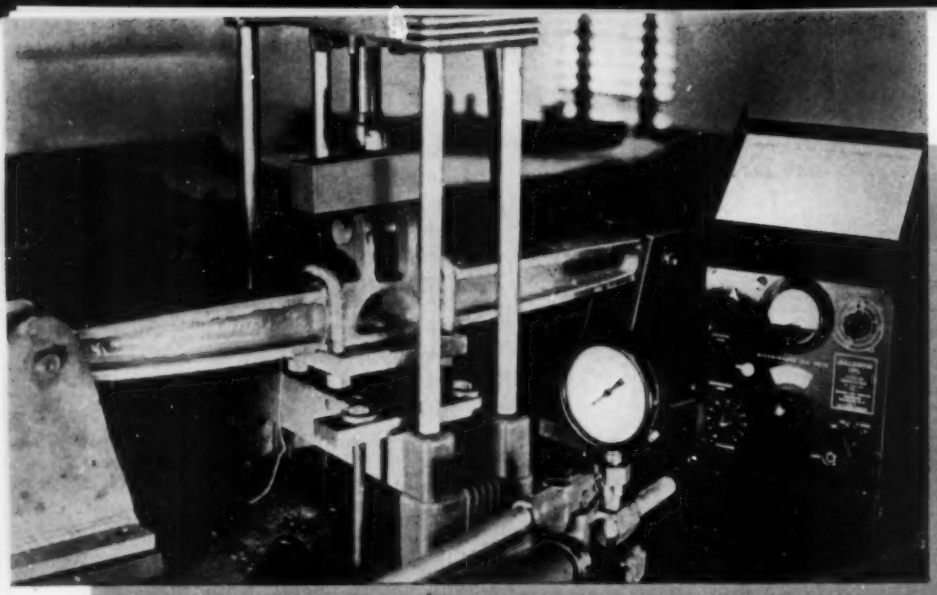


Fig. 1—Test set-up for experimental stress analysis using stress coat and SR-4 strain gages on the beam of Fig. 2 which is shown below.

Fig. 1

Fig. 2—Original design of a cast steel truck-spring lock-out beam. Service failures and production difficulties were eliminated when experimental stress analysis was used to develop a more effective and economical design.

Fig. 2

A Practical Approach to Casting Design

ROBERT J. FRANCK
Superior Steel & Malleable Castings Co.

EXPERIMENTAL STRESS ANALYSIS and scale models provide a means for developing a practical and highly effective approach to the design of castings for critical applications. When one or both of these techniques is combined with joint design-foundry effort, the following advantages can be obtained:

1. Design and foundry methods are tested and proved before the part is released to production.
2. Time and money are saved.
3. With experimental stress analysis, the areas of high stress are located, and, if critical, they can be reduced by design modifications. Also, the foundry can establish its practice to produce sound sections in these areas.
4. Modifications of existing or proposed designs can be made readily to make more effective use of the metal, increase the strength and reduce the cost of a part.

An analysis of the results that were gained during the development of the design of several typical cast steel parts will illustrate both the use of the two techniques and how designer and foundry should work together.

Experimental Stress Analysis

The original design of a 55.9 lb steel truck-spring lock-out beam is shown in Fig. 2. It was designed without foundry consultation. After a large quantity of these parts had been produced, the foundry was asked to improve the quality because of service failures. Poor casting quality was believed responsible for these failures.

After reviewing its procedures, the foundry reported that quality could not be improved with the existing design. Also, it noted the following:

1. The junctions of the ribs and

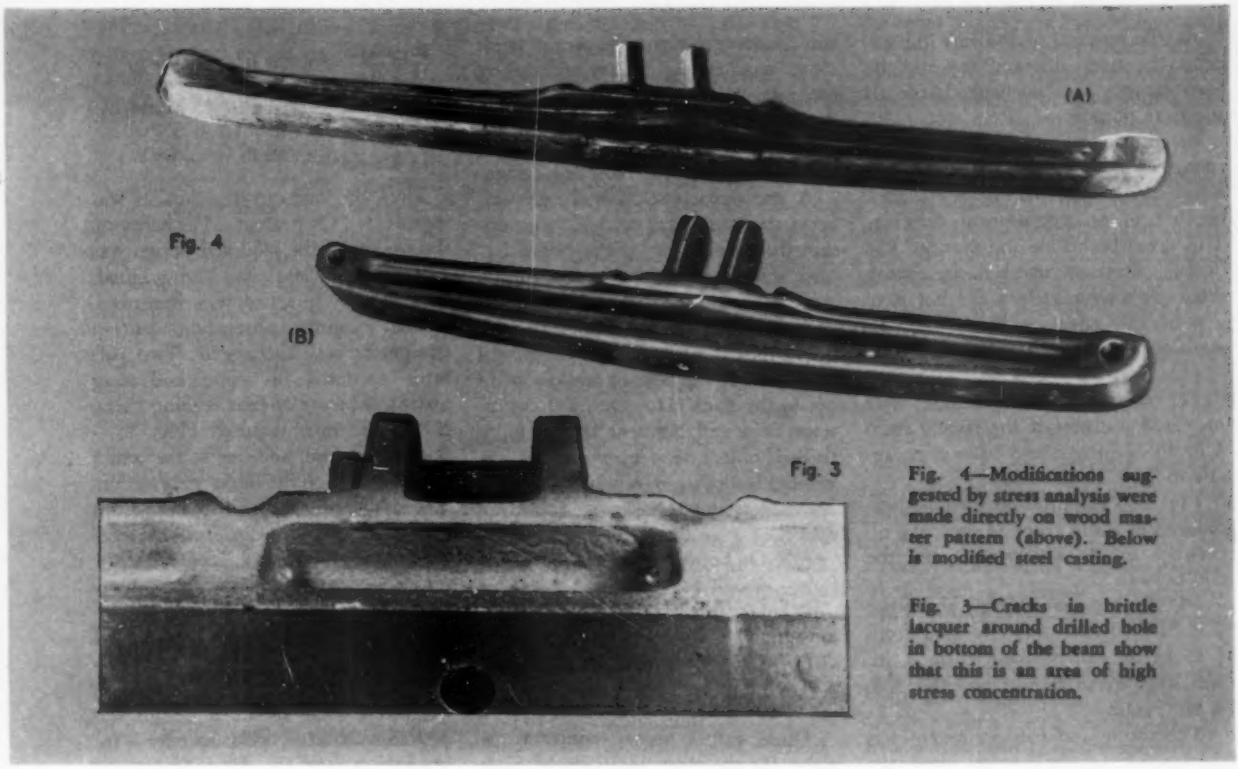


Fig. 4—Modifications suggested by stress analysis were made directly on wood master pattern (above). Below is modified steel casting.

Fig. 3—Cracks in brittle lacquer around drilled hole in bottom of the beam show that this is an area of high stress concentration.

Discusses and illustrates the use of experimental stress analysis and scale models to simplify and improve the design of critical steel castings. Also points out how production problems can be avoided with joint efforts of design and foundry.

lugs with the top and bottom members were conducive to shrinkage;

2. The long, deep pockets required excessive nailing to keep the sand from eroding and becoming trapped in the metal during pouring.

Therefore, an experimental stress analysis of the part was undertaken using stress coat and SR-4 strain gages. The objectives were to determine the load capacity of the existing design and what modifications could be made to eliminate the production problems.

A method of loading the beam statically was developed which would simulate the actual loading, and inexpensive test fixtures were made. Fig. 1 shows the test set-up with the casting mounted on the fixture, and secured by one-inch pins through the holes in each end. A load was applied by a ten ton hydraulic jack to the top of the lugs, putting the bottom member of the beam in tension, and the top member in compression. A completely machined casting was used. A steel plate was fastened to the bottom of the beam by the U-bolts, because it was thought the ribs were necessary to reenforce the casting against the force applied by the U-bolts.

The results of the brittle lacquer test showed the ribs were stress raisers, and the $\frac{3}{4}$ inch drilled hole on the bottom was a critical point. Fig. 3 shows the strain pattern adjacent to the drilled hole. At a load of 6,709 lbs, the apparent tensile stress as computed from the stress coat was 24,000 psi. Since the yield strength of the steel was 40,000 psi the load to start yielding at the joint of high stress would be:

$$\frac{40,000}{24,000} \times 6,709 = 11,200 \text{ lb}$$

The tensile strength of the steel that was used is 65,000 psi. Thus, the load required to start failure at the point of high stress would then become:

$$\frac{65,000}{24,000} \times 6,709 = 18,150 \text{ lb}$$

Since the part was intended for a load of 20,000 lb, this shows that the original design was not satisfactory.

Because the ribs were stress raisers as well as a source of trouble to the foundry, it was decided to remove them to see what effect this would have on the stress distribution. The ribs were machined off of a test casting and another stress coat test was made. The stress distribution was now more uniform except in the area adjacent to the drilled hole. To evaluate this condition, SR-4 gages were placed at the following points:

(1) Bottom, next to hole.
(2) Center of one side.
(3) Bottom, next to bolted plate.

At a load of 6,709 lb, the tensile stresses at these points were 24,180, 13,170, and 16,800 psi, respectively.

Thus, the removal of the ribs did improve the stress distribution—and the load capacity was unchanged, for all practical purposes.

Based on these results, design changes were made directly on the half wood master pattern, Fig. 4, without the aid of an engineering drawing. This saved both time and money. The double shrinkage involved in casting from the master pattern did not have a noticeable effect on the casting dimensions. The changes were:

(1) Ribs were removed.

(2) Bottom tension member was increased at center of the casting from $\frac{1}{2}$ in. to $1\frac{1}{8}$ inches, and tapered gradually to $\frac{3}{4}$ in. at the ends.

(3) Top compression member was reduced in width from $2\frac{1}{2}$ in. to $1\frac{1}{8}$ in. between the U-bolt grooves and the end bosses.

(4) Web section directly above the $\frac{3}{4}$ in. drilled hole was increased from $\frac{1}{2}$ to $1\frac{1}{2}$ in. and blended to the $\frac{1}{2}$ in. web, approximately 3 in. on either side of the center.

The gating and risering system was determined in conjunction with the design changes, and wooden gates and risers were attached to the wood master pattern. Five castings were made from this master pattern equipment with close engineering follow-up during molding. All five passed X-ray, magnaflux and dimensional inspections. One was machined for an experimental stress analysis of the modified design.

A stress coat test showed that uniform stress distribution had been obtained; the cracking of the brittle lacquer showed that the apparent tensile stress at a 6,709 lb. load was 10,500 psi. As the load was increased to 8,946 lb. the stress pattern blossomed out all along the bottom tension member to the ends. However, the critical stress was still adjacent to the $\frac{3}{4}$ in. drilled hole. SR-4 strain gages cemented in the same locations as on the original casting, gave the following results at a load of 6,709 lb:

(1) On bottom next to $\frac{3}{4}$ in. drilled hole—10,350 psi, tension.

(2) On side at center—6,360 psi, tension.

(3) On bottom next to bolted plate —9,690 psi, tension.

These values show reductions in stress for the three locations of 57.5, 51.8 and 42.4 percent, respectively. Using the highest stress, 10,350 psi, the load to start yielding would be:

$$\frac{40,000 \text{ psi}}{10,350 \text{ psi}} \times 6,709 \text{ lb} = 25,900 \text{ lb}$$

The load to start failure would be:

$$\frac{65,000 \text{ psi}}{10,350 \text{ psi}} \times 6,709 \text{ lb} = 42,500 \text{ lb}$$

Thus, the load carrying capacity was increased 235 percent. Furthermore, the weight of the modified design was three pounds less than the original, and foundry practice was improved.

The original production pattern equipment was unchanged: Two patterns mounted on cope and drag boards. In place of four feeding risers, three were now required (Fig. 5)—one at each end, and one in the center feeding through the heavy web section. There were no heavy isolated junctions that required difficult or excessive feeding risers. The long, deep, narrow pockets were eliminated, and there were no abrupt changes in contour. The gradual blends in the surfaces did not permit sand to be washed off during pouring and becoming trapped in the metal. The modified design was proved satisfactory prior to release for production, and the development was done in 249½ man hours. Tooling-up for production was simplified, even though an engineering drawing had

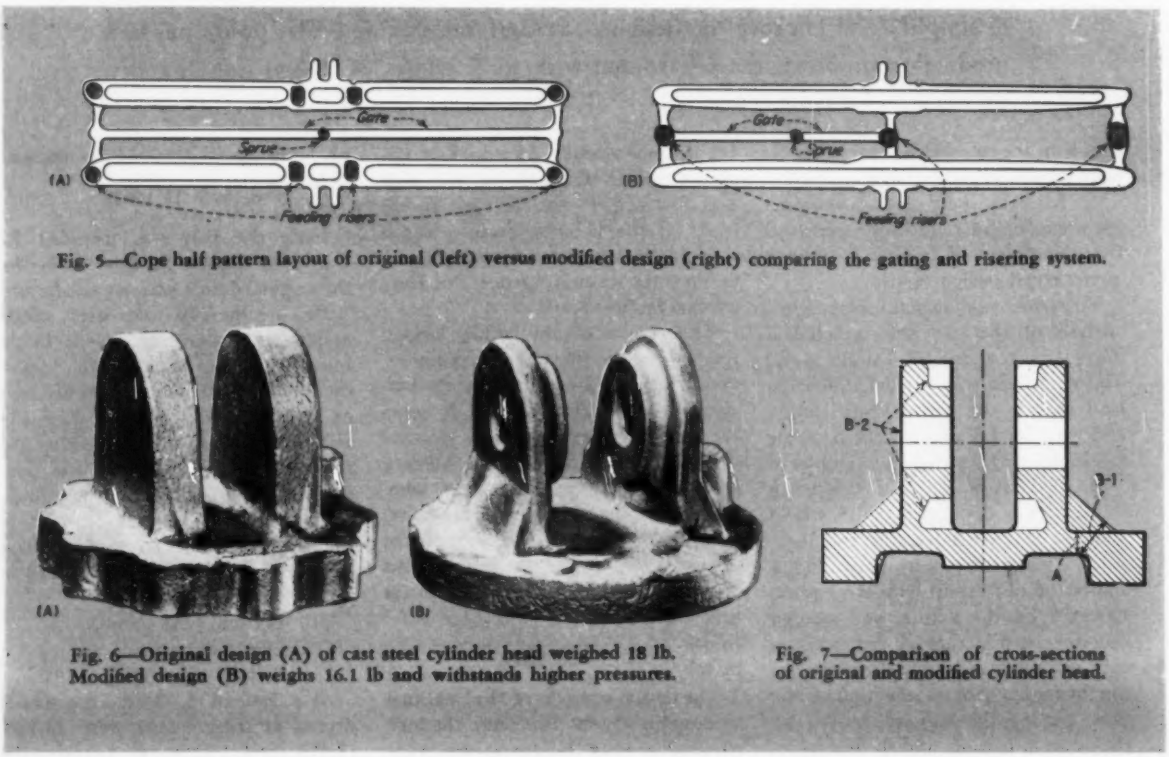


Fig. 5—Cope half pattern layout of original (left) versus modified design (right) comparing the gating and risering system.

Fig. 6—Original design (A) of cast steel cylinder head weighed 18 lb. Modified design (B) weighs 16.1 lb and withstands higher pressures.

Fig. 7—Comparison of cross-sections of original and modified cylinder head.

not been made. The production metal pattern equipment was made from the modified wood master pattern, incorporating the gating and risering system which was developed during the production of the experimental castings. An engineering drawing was made during this tooling-up period. The critical stress areas were marked on a print which was given to the foundry, permitting them to set up proper production and inspection procedures.

Models

Models for casting development work can be made full size or to any convenient scale. A wide selection of materials are available, such as clay, wood, plaster, wax, and various plastics. One advantage of working with models is that the designer can see his ideas solidify before him. Shape is not as elusive as it is in many cases on the drawing board.

Furthermore, models are easily understood by everyone concerned, and during conferences, changes can be made rapidly without long involved discussions over detailed drawings. Pattern layout, coring, gating and risering systems can be made easier and more accurately than on drawings.

Free hand sketches are usually made in conjunction with the model, since they assist in the construction and save time and effort during its development. Where a print is available, changes can be sketched directly on the drawing. This layout can then be used for the construction of the model. In some cases the model will serve as a pattern for experimental casting, and the casting can be machined for making experimental stress analysis.

If the results of the experimental stress analysis show that design changes are necessary, they can be readily made on the model. When the design has been proved satisfactory, the model will be useful in making the pattern equipment. Also, it is an aid in laying out tooling requirements. Again, the design of the part will be proved prior to release for production, and the engineering drawing can be made from the model.

For illustration, Fig. 6(A) shows the original design of a cast steel cylinder head that was intended to withstand 1,000 psi hydrostatic pressure. A shrinkage condition was encountered at the base of the heavy lugs, and it was impossible for the foundry to eliminate this condition completely. Machined castings were pressure tested; machining cost was a total loss on parts that developed leaks.

By means of a model study, the modified design Fig. 6(B) was developed. Although the modified head required more coring, this presented no problem since the shape was worked out with the molder. To discuss the details of these designs, a cross section is shown in Fig. 7. The heavy black line is the original design. The casting is molded in the position shown, with the parting line at the top. The top of the outer rim is the only feasible place to locate the feeding risers in both designs.

Point "A" on the original design shows the thin section between the lugs and outer rim. The metal solidifies at this section first, and impairs feeding action from the outer rim, causing an uncontrolled shrinkage condition at the base of the lugs.

Point "B-1" on the modified design, shows the increased metal section toward the outer rim, permitting metal to solidify progressively from the bottom of the lugs to the rim where feeding risers are located. This eliminates the cause for the shrinkage condition.

Point "B-2" of the modified design shows how the heavy lug sections have been reduced to permit uniform directional solidification by removing metal without loss of strength.

The results of this redesigning brought about a 9.4 percent saving in cost plus a 10.6 percent weight reduction. In addition, it was assured that the castings would pass the pressure test, and reduce machining losses.

Design–Foundry Cooperation

Both of the parts described previously point out that close cooperation between design and foundry is an essential part of a good development program. Some of the points the designer should discuss with the molder are location of parting lines, pattern layout, coring problems and gating and risering requirements.

Cooperation during the initial development stages allows the designer to determine a shape that can be cast satisfactorily and have the strength required to meet service needs. A good example of where this was done is illustrated by Fig. 8(A). This shows the proposed design for a 380-lb, one-piece cast steel conveyor belt pulley. The foundry pointed out that the following production problems were inherent to this proposal:

1. A one-piece casting would be difficult and expensive to produce. It could not be gated and risered satisfactorily.

2. The large center core could not be properly anchored to insure dimensional stability.

3. The shape was conducive to cracking and tears.

The foundry suggested that the solution to these problems would be to cast the pulley in two sections, and weld them together. Design agreed. The two cast halves, were machined and welded at the center as shown in Fig. 8(B). This resulted in a 13.6 percent saving in cost. Also, the modified design permitted the foundry to use good practice. Less expensive pattern equipment was required since each half was cast from the same pattern. An efficient gating and risering system assured consistently sound castings. Elimination of the large costly center core gave dimensional stability, and also eliminated the cracking.

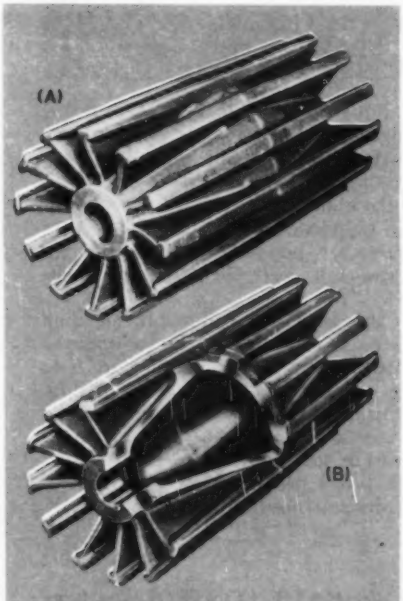


Fig. 8—Proposed design (A) of a one-piece cast steel conveyor belt pulley. Cutaway view (B) shows cast weld construction that eliminated production problems of one-piece casting.

Pneumatic Safety Circuits

H. L. STEWART
Logansport Machine Company, Inc.

PNEUMATIC POWER CIRCUITS on presses, holding devices, and equipment with complicated interlocks should be designed to fail safe whether the fault lies in improper operation or mechanical failure. Thus, safety circuits can serve two purposes: to protect the operating personnel; and to prevent damage to expensive machinery and work pieces.

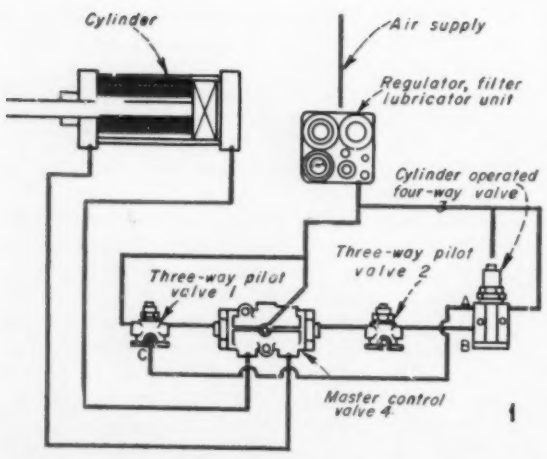
Since air powered devices are inherently fast operating, pneumatic press operators must be protected by safety circuits if the operator loads workpieces directly under the press ram. These circuits incorporate series hand and foot operated valves which must be actuated before the cycle can begin.

In clamping and holding circuits, low air pressure may cause insecure clamping, with possible damage to machine and operator during the work cycle. Low pressure devices should be used which will stop the machine when the line pressure falls below a predetermined minimum value.

In complicated quick cycling circuits, proper interlocks should be supplied to prevent the various circuit components from operating out of sequence. Interlocking is usually accomplished electrically through limit switches, or pneumatically through cam operated valves or speed control valves.

Manually operated emergency stop or return controls enable the operator to stop a machine in the event that he observes a fault in operation which is not compensated for automatically. This type of control can either be arranged to hold all circuit components in the position they are in at the time the operator notices the fault or to return all components to their start-of-cycle position.

The following diagrams show the use of these safety and protection principles in several pneumatic circuits.



1. LOW PRESSURE PROTECTION. One method of protecting against a low pressure condition is to control the supply air with a valve which is sensitive to line pressure. A cylinder operated valve, which is actuated by line pressure, can be arranged to either stop the cycle or return the system components to their initial positions when the pressure drops below an allowable minimum.

When the line pressure is normal, cycle operation can be initiated by manually operating pilot valve 2. Port *B* of valve 3 is open to the line, so that master valve 4 will shift to admit air to the blind end of the cylinder. Under this condition, port *C* of pilot valve 1 is open to exhaust through port *A* of valve 3. The cylinder can be retracted by actuating pilot valve 1 to shift the master valve the other direction.

If the line pressure drops below the allowable minimum while the cylinder is on the outstroke, cylinder operated valve 3 will shift to open port *A* to line and port *B* to exhaust. Air pressure will be admitted to port *C* of pilot valve 1 causing the master valve to shift and the cylinder to retract. Thus, an excessive drop in line pressure causes the cylinder to return to its starting position.

This circuit operates on a pressure pilot principle. A similar circuit can be designed using a bleeder pilot operated master valve.

2. FOUR HAND PNEUMATIC CONTROL. On large machines where two operators are required to handle the workpieces, four series connected valves can be used to keep both hands of both operators clear of the machine during the work cycle. If any one of the valves is released, the cycle will either stop or return to the starting position depending on the circuit design.

When the four series pilot valves, *A*, *B*, *C* and *D* are

manually actuated, air is admitted to the pilot piston of valve *E* and this valve is shifted in the direction to advance cylinder *K*. The rate of advance is controlled by the setting of the flow control valve *F*. When the piston connected cam actuates valve *G*, cylinders *H* and *J* advance and clamp the workpiece. The cylinder is retracted by releasing valves *A, B, C* and *D*. Valve *E* is shifted by the spring and air is admitted to the rod end of the cylinder. When cam operated valve *G* is released, the clamping cylinders retract.

Should the operator at station 1 actuate valves *A* and *B* while the operator at station 2 is still positioning his part of the workpiece in the machine, nothing will happen. Also, if during the cycle one of the valves is released, the cylinder will retract. A circuit such as this is important where two operators cannot see one another or where noise is at a level where they cannot hear one another.

3. ELECTRICAL TWO HAND CONTROL. With solenoid operated pressure pilot valves, two hand protection can be obtained through interlocking electrical circuitry. This is an advantage if the operator is located some distance from the master valve.

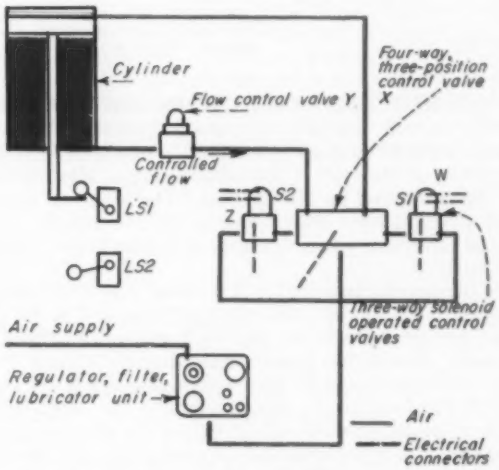
By pressing pushbuttons 1 and 2 (placed far enough apart so that they cannot be operated with one hand), solenoid *S2* of valve *Z* is energized. Valve *X* shifts and the cylinder advances. When the cylinder reaches the outward end of its stroke, limit switch 2 is actuated. The motor driven timer is energized through the normally open contact of limit switch 2. At the end of the preset time interval, solenoid *S1* of valve *W* is energized and the cylinder retracts. This cycle is not repeating so that when the cylinder reaches its starting position either or both pushbuttons 1 and 2 must be released to start a new cycle. This will de-energize solenoid *S2* and reset the timer.

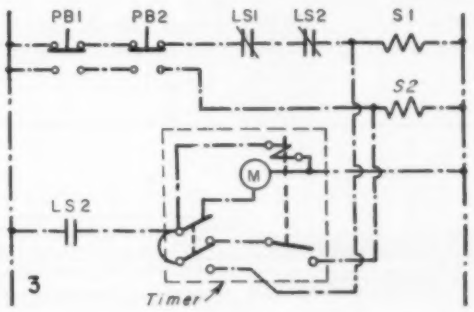
If either pushbutton is released during the cycle, both solenoids will be de-energized and valve *X* will center, stopping the cylinder. Flow control valve *Y* regulates the speed at which the cylinder advances.

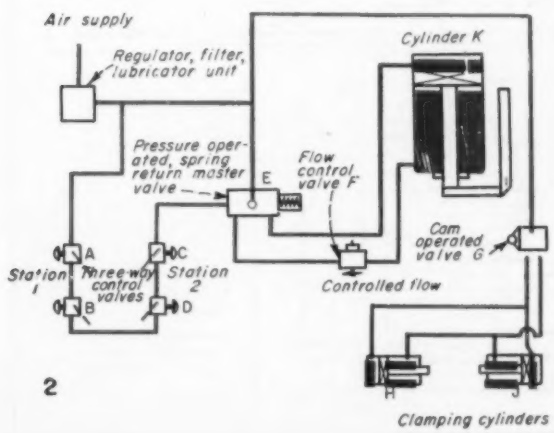
4. TWO HAND OPERATOR PROTECTION. On air powered presses where the operator loads the work under the press ram, operator protection can be obtained by using two series connected valves, both of which must be manually actuated before the press will operate.

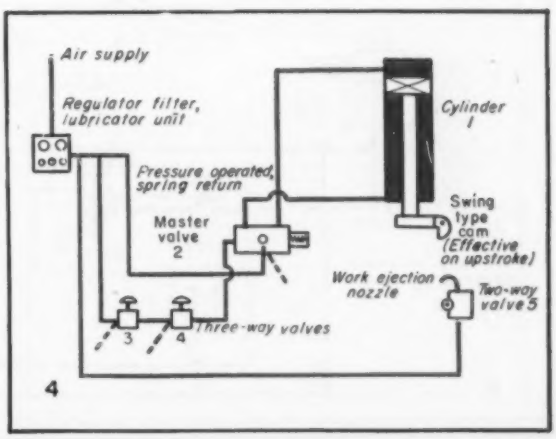
In this circuit, the operator places the work on the press and then actuates valves 3 and 4. These valves are of the spring return type, requiring the operator to keep his hands on each handle during the pressing stroke. The master valve shifts admitting air to the blind end of cylinder 1. At the completion of the stroke, the operator releases valves 3 and 4 and the spring shifts valve 2 causing the piston of the cylinder to retract. Cam operated valve 5 is actuated on the upstroke and emits a blast of air to blow the workpiece off the press bed.

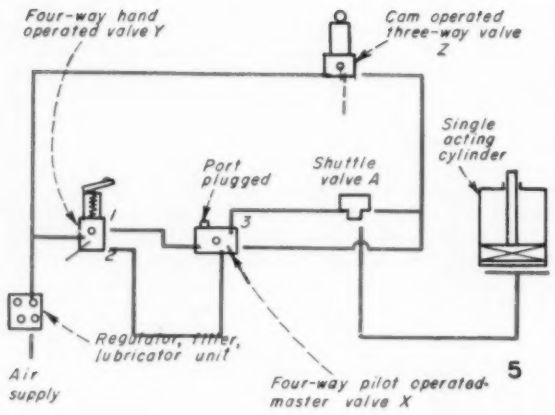
By replacing the master valve which is shown here by a three position closed center valve, the cylinder will stop instead of returning to the retarded position if the operator releases either valve 3 or 4. This is an advantage on long stroke cylinders. Often a foot valve is used for the upstroke of the press. This foot valve will only raise the ram; both hand valves must be actuated to lower it.











5. INTERLOCKED MACHINE PROTECTION CIRCUIT. In some machines, operator judgment is depended upon for proper operation for a portion of a cycle while the remainder of the cycle is sequenced automatically and cannot be controlled by the operator. The point of switchover to completely interlocked control is usually some critical condition where improper operation might damage the machine.

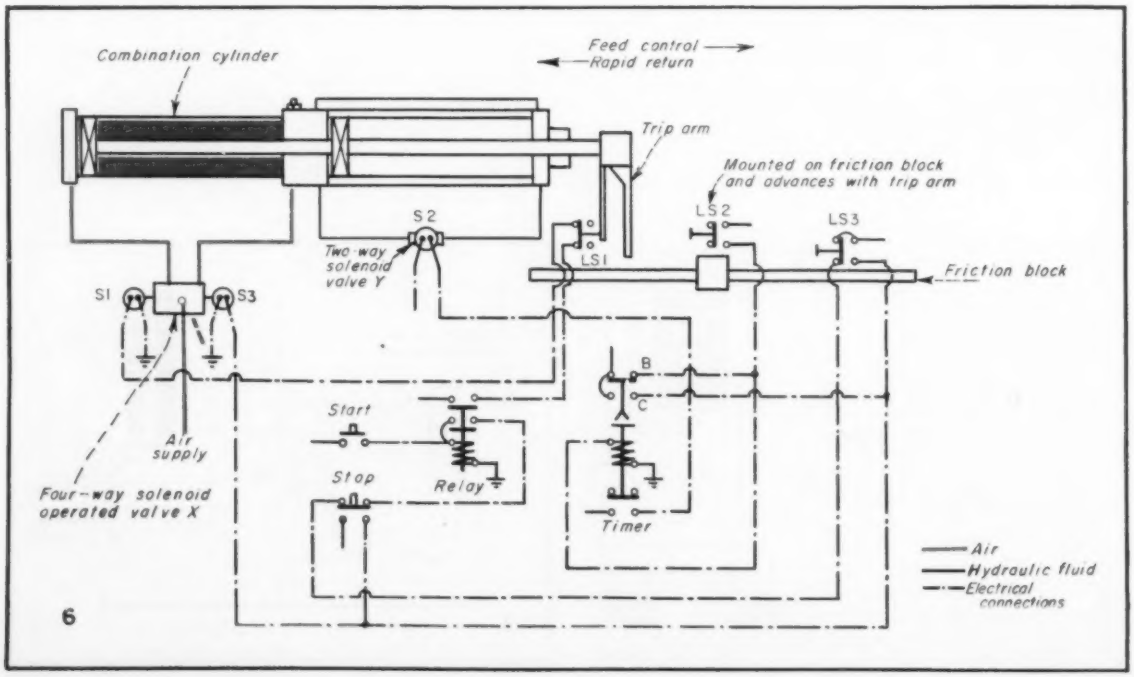
In the starting position for this circuit, port 1 of valve *Y* is open to the supply. Line pressure is applied to the left hand port of valve *X* and port 3 of this valve is open to the inlet. When the operator actuates valve *Y*, port 2 of this valve opens to the line and supply air flows from port 3 of valve *X* to the shuttle valve *A*. The shuttle valve shifts to admit air to the blind end of the cylinder and it advances. The cylinder actuates a mechanism (not shown) which in turn depresses the roller on valve *Z*. Air is admitted to the right hand pilot port of valve *X* and causes the valve to shift (since the other pilot port is open to the exhaust through port 1 of valve *Y*). Port 3 of valve *X* is then open to the exhaust and valve *A* shifts to admit air to the cylinder and keep it locked out. After a period of time, valve *Z* is released and a port is opened to the exhaust. This in turn opens the blind end of the cylinder to the exhaust and it retracts even if the operator is still depressing valve *Y*. This is a nonrepeat circuit, and the operator must release valve *Y* before a new cycle can start. Releasing *Y* shifts valve *X* to its starting position.

With this circuit, the operator can reverse the cylinder travel at any point in the stroke until the cam operated valve is actuated. Reversal is accomplished by releasing valve *Y*. After valve *Z* is actuated, the cycle continues regardless of the position of the manual valve.

6. ELECTRICAL EMERGENCY STOP AND OVERTRAVEL LIMIT. Automatic repeating cycles will continue to repeat unless stopped by manual means, by equipment failure, or by safety control devices. This circuit is equipped with an automatic overtravel stop which will return the cylinder to its normal position regardless of the reason for overtravel, and an emergency stop which can be manually operated to stop the cycle.

The cycle is initiated by pressing the *start* button. This closes the relay, which in turn energizes solenoid *S1* of valve *X* through limit switch 1. Air is admitted to the blind end of the combination cylinder. This cylinder advances at a high rate until the trip arm contacts the friction block and limit switch 2. The timer is energized and in turn energizes solenoid *S2* of valve *Y* through normally open contact of timer. This restricts the flow of hydraulic fluid in the combination cylinder and reduces the feed rate. The cylinder advances at this lower rate until the preset time is elapsed. At the end of this period the timer opens, solenoid *S3* is energized and the cylinder returns to its normal position. Limit switch 1 is actuated and a new cycle begins.

If the trip arm actuates limit switch 3, the relay holding



circuit is broken, solenoid *S3* is energized and the cylinder retracts to its inward position and remains there until the start button is actuated again. This condition could result from an incorrect time interval, a broken tool, or an empty workpiece magazine. The emergency *stop* button can be used at any time to stop the cycle and return the cylinder to its starting position.

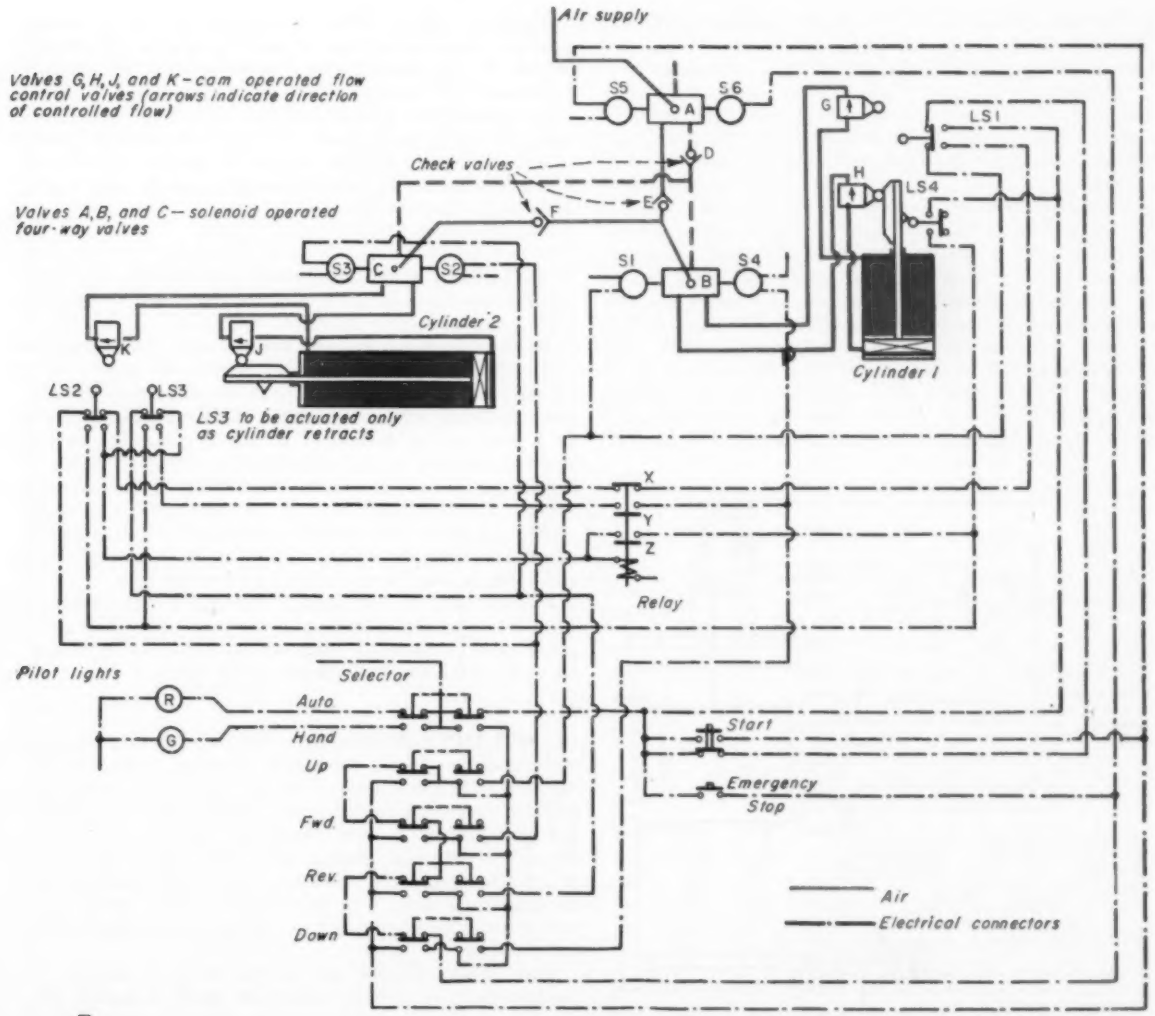
7. EMERGENCY STOP WITH CHECK VALVES. In complicated circuits where the emergency stop arrangement only shuts off the supply air, the system components may drift from their stopped position because of air leakage and transfer of air between components. This can be prevented by the use of check valves in the proper supply and exhaust lines.

The automatic cycle is started by pressing the *start* button. Solenoid *S5* of valve *A* is energized directly and solenoid *S1* of valve *B* is energized through limit switch 1. Valve *A* shifts to admit supply air to the system and valve *B* shifts to admit air to the blind end of cylinder 1. This cylinder advances until limit switch 1 is actuated. Solenoid *S1* of valve *B* is de-energized and solenoid *S2* of valve *C* is energized through relay contact *X* and limit switch 2. Valve *C* shifts and the piston of the cylinder 2 moves to the left.

When limit switch 2 is actuated by cylinder 2, the relay closes, solenoid *S2* is de-energized, and solenoid *S3* is energized through limit switch 3, relay contact *Z* and limit switch 4. Cylinder 2 retracts until limit switch 3 is actuated. Valve *B* reverses as solenoid *S4* is energized through limit switch 3, and cylinder 1 retracts. At the inward end of the stroke, cylinder 1 actuates limit switch 4 and the relay opens. The cycle will then repeat automatically. The speed of travel of the cylinders is controlled by cam operated flow control valves *G, H, J,* and *K*.

If the emergency *stop* button is pressed at any time during the automatic cycle, solenoid *S6* of valve *A* is energized and the system supply air is shut off. Both cylinders are stopped and held as inlet air from a port of valve *A* is blocked by check valve *D* and exhaust air from the two cylinders is blocked by valves *F* and *E*. Check valve *F* also prevents a transfer of air between cylinders 1 and 2.

Each sequence can be operated manually by actuating one of the four individual pushbutton stations. When any one of these pushbuttons is pressed and then released, solenoid *S6* is energized to stop and hold both cylinders. The pilot lights indicate whether the selector switch is set for automatic or hand operation.



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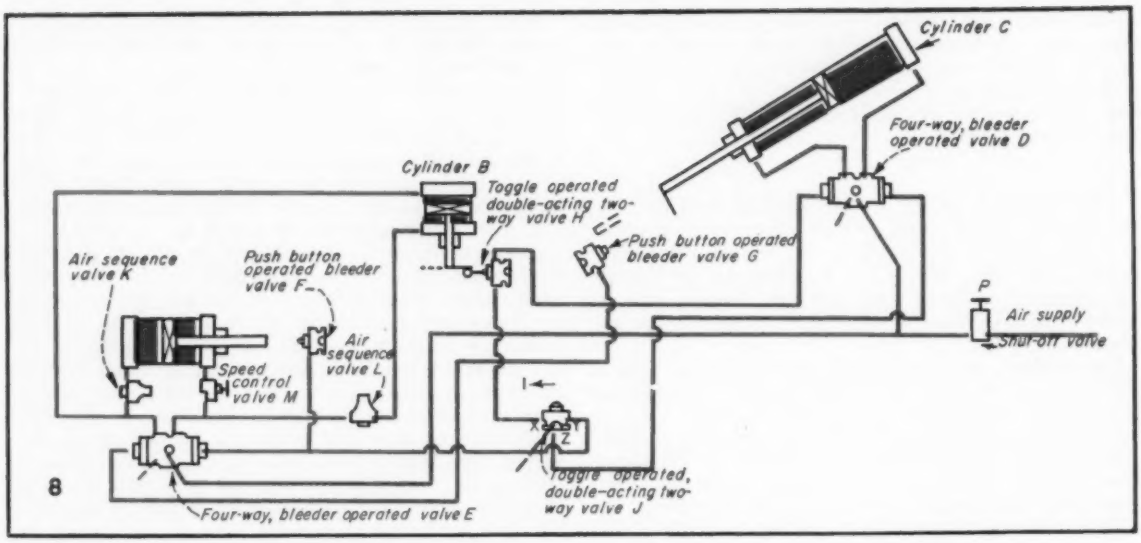
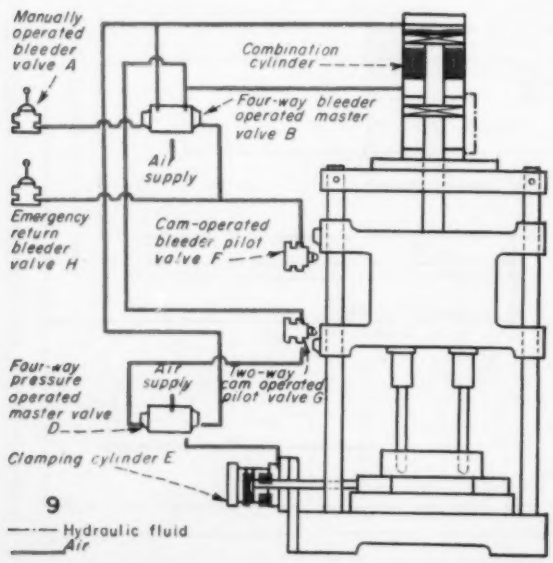


8. EMERGENCY RETURN AND HOLD CIRCUIT. With this arrangement, one manually operated bleed valve controls the emergency operation of three cylinders.

Opening shutoff valve *P* admits supply air to the system and starts the automatic cycle. Bleeder operated valve *D* shifts to admit air to the blind end of cylinder *C* and this cylinder advances. The right hand bleed port of valve *D* is open to the exhaust through ports *Z* and *X* of valve *J* and through port *W* and the exhaust port of valve *H*. When cylinder *C* reaches the end of its stroke, valve *G* opens and valve *E* admits air to the blind end of cylinder *B*. At the outward end of its stroke, cylinder *B* actuates valve *H*, and at the same time, line pressure builds up and sequence valve *K* opens. The operation of *H* closes port *X* of valve *J* to the exhaust and opens the left hand port of valve *D* to the exhaust. Valve *D* shifts and cylinder *C* retracts. Valve *K* admits air to cylinder *A* and this cylinder advances at a rate controlled by valve *M*. At the outward end of the stroke, valve *F* is actuated and valve *E* reverses. Cylinder *A* retracts. When cylinder *A* reaches its starting position, sequence valve *L* opens and cylinder *B* retracts. When the trip on cylinder *B* releases valve *H*, cylinder *C* starts to advance again and the cycle repeats.

If, during the cycle valve *J* is moved to position 1, port *Z* is blocked and ports *X* and *Y* are opened directly to the exhaust. Cylinders *A* and *B* retract. Cylinder *C* will also retract and cannot advance again to start a new cycle until *J* is released.



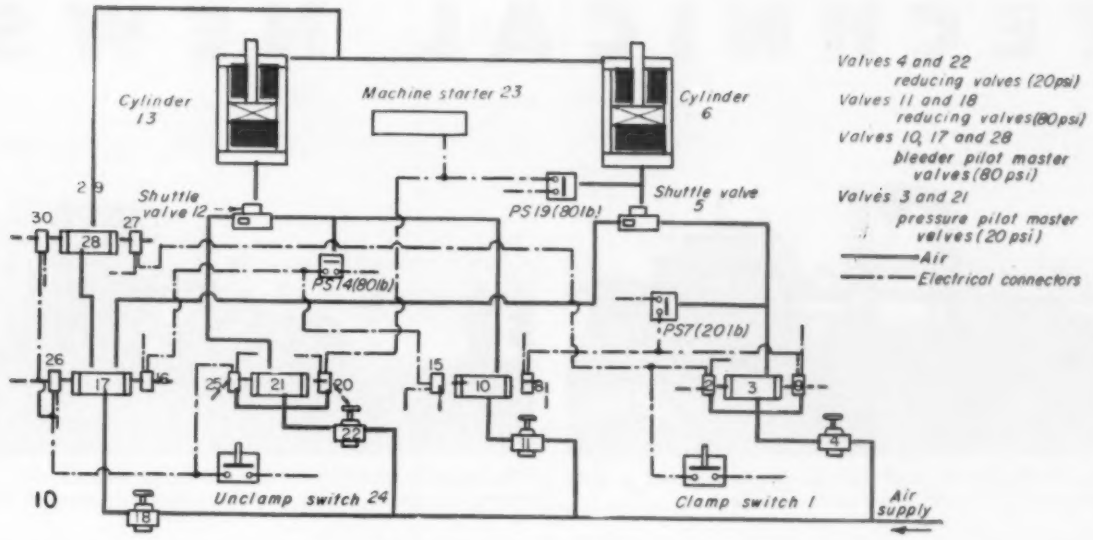
9. PNEUMATIC EMERGENCY RETURN. This diagram shows a pneumatically powered drill press feed circuit with an emergency return valve.

By manually operating pilot valve *A*, the spool of valve *B* shifts to admit air to the blind end of the combination cylinder and to the right hand pilot port of valve *D*. Clamping cylinder *E* advances to clamp the workpiece and the drill head moves downward at a rate controlled by the hydraulic section of the combination cylinder. Valve *F* is adjusted so that it trips at the bottom of the required stroke. Valve *B* reverses and the combination cylinder retracts. During the upward stroke, valve *G* is actuated to unclamp the workpiece. This circuit is nonrepeating and valve *A* must be operated to start a new cycle.

Bleeder valve *H* is in parallel with valve *F* and reverses valve *B* causing the drill head to move upward. This emergency valve is manually operated and can be used to stop the cycle in the event of danger to the machine.

10. MULTIPLE PRESSURE CIRCUIT. In this machine tool chucking circuit, the chuck actuating cylinders are supplied with low pressure (20 psi) or high pressure (80 psi) air depending on the cycle requirements. In general, low pressure air is used while the workpiece is being aligned in the chuck during setup and high pressure air is used to insure the workpiece is solidly held during the machining cycle. The shuttle valves in the system prevent the air from bypassing to exhaust during changeover and holding.

Both chuck cylinders are in the retracted position at the beginning of a cycle . After the work is loaded, the *clamp* button is pressed energizing solenoid valves 2 and

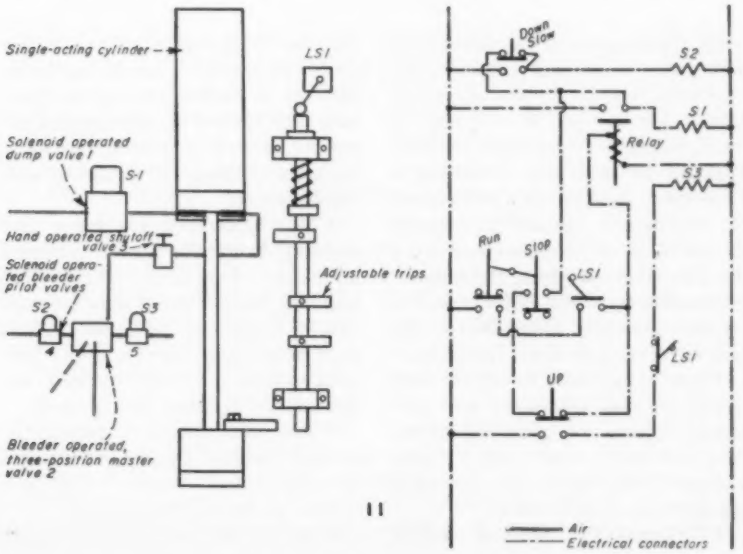


27. Master valve 28 shifts, exhausting the rod ends of cylinders 6 and 13, while valve 3 admits low pressure air to the blind end of cylinder 13 through shuttle valve 5. When cylinder 6 reaches the end of its stroke, pressure builds up and closes pressure switch 7. This energizes solenoid valves 8 and 9, shifting valve 3 so that the blind end of cylinder 6 is open to the exhaust and shifting valve 10 to apply high pressure air to cylinder 13. When cylinder 13 advances full stroke, line pressure builds up and closes pressure switch 14. This energizes solenoid valves 15 and 16. The blind end of cylinder 13 exhausts through valve 10 and high pressure air is applied to cylinder 6 through valve 17. Pressure buildup in the blind end of cylinder 6 actuates pressure switch 19. The machine starter and solenoid valve 20 are energized, starting the machining and admitting low pressure air to cylinder 13 through valve 21. This completes first half of cycle.

At the completion of the machine work, the *unclamp* switch is actuated. This energizes solenoid valves 25, 26, and 30. Valve 21 shifts to exhaust the blind end of cylinder 13 and valve 17 shifts to exhaust the blind end of cylinder 6 and admit high pressure air to the rod end of both cylinders and the cylinders retract.

11. ELECTRICAL INTERLOCKS AND CONTROLS. This drop hammer air circuit has provisions for inching the hammer down during setup, for dumping air on the working stroke, and for varying the height the hammer drops. Control and interlocking to maintain proper sequence are completely electrical.

While the dies are being adjusted, the *up* button is pressed to raise the hammer. This energizes solenoid *S*3 through the normally closed contacts of limit switch 1 and valve 2 shifts to admit air to the cylinder. When the upper end of the stroke is reached (depending on which trip is in position), limit switch 1 opens and valve 2 centers. The hammer can be inched down by pressing the *down* button and energizing solenoid *S*2 of valve 4. If the hammer is to be kept in the up position for any length of time, hand operated valve 3 should be closed.



To start the working cycle, the *run* switch is closed and the *up* button pressed. As during setup, solenoid *S*3 will be energized and the hammer will rise until limit switch 1 is tripped. The relay is energized through the *run* switch and limit switch 1 and locks in through the *up* contact (which has been released) and the normally open contacts of the *stop* button. The relay energizes solenoid *S*2 of valve 4 and solenoid *S*1 of dump valve 1. The hammer drops rapidly. If the *up* button is not released at the proper moment, the relay will open and the hammer will not drop. The *up* button must be pressed to start each cycle.

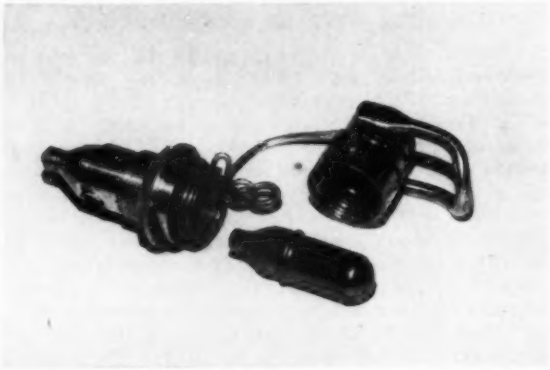
In process operations where the hammer is dropped, dump valve should be large to prevent a buildup of back pressure in the cylinder.

TECHNICAL NEWS

TRACTOR-DRAWN ROOTER digs up frozen ground as Army studies its performance under arctic conditions.

WINTERIZED GRADER has insulated enclosures and forced air heating for operator, adequate for temperatures above —30F.

TRUCK-MOUNTED CRANE-SHOVEL at work in arctic testing grounds. Low temperatures caused high mortality rate on wire cables; increasing diameter of cables failed to increase their life.



PRIMER FLUID packaged in steel capsule can be released with this hand discharger in emergencies. During Operation Beaver the capsules proved highly successful as a starting aid.

OPERATION EAGER BEAVER I:

BOTH MEN AND MACHINES perform badly when exposed to below zero temperatures unless they've been properly protected against icy blasts. Since the end of World War II, the U. S. Army has been busy developing winterization equipment to protect soldiers and equipment at temperatures as low as —65 F. To test such gear under actual field conditions, the Corps of Engineers launched Operation Eager Beaver I in the Yukon Territory during the winter of 1952.

For three months, army engineers, aided by Canadian troops, carried out routine construction tasks—building roads, leveling air strips, clearing ice and snow—under sub-freezing arctic conditions. As the temperature varied from a low of —65 F to a high of 30 F, scientists from Fort Belvoir's Engineer Research and Development Laboratory checked the performance of mechanized equipment, watched the condition of personnel, and noted the difficulties that both encountered.

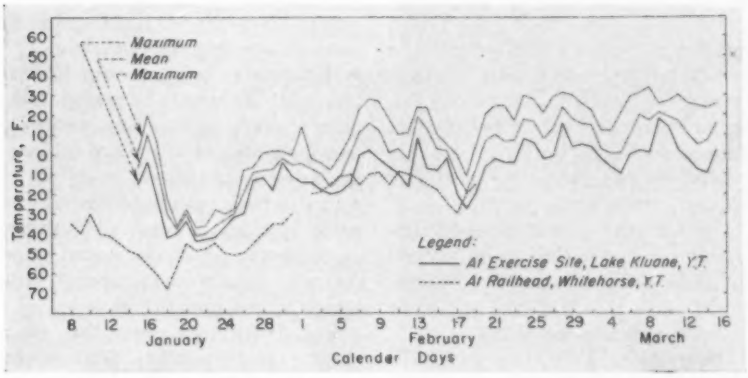
▶ **Conclusions.** Now ERDL researchers have evaluated Eager Beaver data and have reached these conclusions:

- Low temperature is not the only factor affecting equipment and personnel exposed to arctic conditions. Also involved: wind and "storage soak-out"—the result of prolonged exposure to ice and snow.
- Personnel not properly trained for low temperature conditions are unable to operate or service machines. Majority of breakdowns and malfunctions were blamed on awkwardness developed by men unaccustomed to wearing arctic clothing and unused to such numbing cold.
- Most protective enclosures and warming devices for personnel proved inadequate. Experience indicates that operators' compartments must be more heavily insulated; personnel heaters must have bigger capacities; and protective coatings for hand operated controls should be more widely used.
- Slave kits already developed for starting internal combustion engines at temperatures between —20 and —40 F performed satisfactorily.
- Special lubricants and anti-freezes

For more on Winterization of Engineering Equipment, see Product Engineering, *June 1953, p. 150.*

U. S. ARMY KEY WINTERIZATION COMPONENTS

Product Designation	Specification	Operating Temperature
Batteries, Storage, (for) Military Motor Vehicles, Types 2H and 4H	USA 91-88A	To −40F or Below
Heaters, Personnel, Gasoline-Burning	MIL-H-3199	To −65F
Heaters, Power Plant, Gasoline-Burning	MIL-H-3177A	To −65F
Heaters, Power Plant, Gasoline-Burning	Experimental	To −65F
Heater, Utility, Gasoline-Burning	USA 94-40676	To −65F
Insulation, Thermal ("Permalastic," "Coro-Gard," and "Seal-Peel")	Experimental	To −65F
Primers, Gasoline-Engine, Hand Operated	MIL-P-3306	To −65F
Primers, Pressure, Internal Combustion Engine Cold Starting ("Chevron" Metal Capsules)	MIL-P-16912	To −65F
Discharger, Pressure Primer (Fixed Type)	Experimental	To −65F
Discharger, Pressure Primer (Hand Type)	Experimental	To −65F
Kit, Cold Starting Aid, M40 ("Slave Kit")	MIL-S-10938	To −65F
Receptacle, Charging	USA AXS-1659	To −65F
Kits, Arctic Winterization (Various Types)	.....	To −65F
Kits, Arctic Winterization (Various Types)	.....	To −65F



TEMPERATURE RECORD maintained during exercise shows that weather conditions at the Whitehorse railhead put the group to the severest tests, ranging to −65F with icy blasts that slowed unloading operations considerably.

ARCTIC TESTING

developed specifically for temperature extremes proved so satisfactory that ERDL plans no changes in current specifications for these materials.

▶ **The Human Element.** Acclimating men to freezing cold proved to be the task force's number one problem. Guinea pig engineers reported that handling small tools with arctic mittens was particularly difficult because the hands become numb so quickly, necessitating frequent stops. This, of course, slows servicing functions.

Also the group ruined a large number of hand tools. The reason: men hampered by heavy arctic clothing were unable to use the tools properly.

▶ **Starting Aids.** With a battery in good condition, a well tuned engine, and a properly trained operator, most engines protected by arctic fuels and lubricants can be cranked and started in the ordinary manner at temperatures as low as −20 F. In colder weather, auxiliary equipment is needed.

At temperatures below −35 F, the engineers were able to start equipment with a so-called slave kit composed of: (1) four, 6-volt, lead-acid-type arctic batteries, designed to supply high amperage discharge for peak starting conditions at temperatures down to −40 F; (2) a single-cylinder-gasoline-engine-driven, 1,500 watt, 30 v, d.c. electric generator for charging the batteries; (3) controls and regulators including a switch-board to select 6, 12, and 24 volt circuits; (4) an electric-motor-driven, gasoline-burning, hot air heater of 100,000 BTU capacity; and (5) a manually controlled duct to direct hot air.

To start equipment at extremely low temperatures, the slave kit sprays hot air over critical parts like fuel tanks, lubricant reservoirs, coolant supply, etc; then jump wires are connected from the slave kit batteries to help those installed on the machine crank the main power plant.

For warming smaller equipment and accessories the engineers use a hand-cranked slave kit that supplies substantial amounts of hot air quickly. An independent gasoline burning unit with its own fuel tank, combustion chamber, and air fan blower, it supplies 40,000 BTU.

Another way of starting engines in frigid weather is to inject a priming fluid like Chevron into the intake manifold of the engine. The primer—which has a seven fold wider range of inflammability than pure hydrocarbons—improves the combustibility of the fuel so that self-ignition takes place at lower temperatures. Other ingredients provide top cylinder lubrication and make the fluid more stable in storage.

Safe handling of the primer was assured by a new packaging technique developed for both the Corps of Engineers and the U. S. Navy. Steel bulbs, similar to those used for charging water with carbon dioxide, are filled three-quarters full of fuel and pressurized to 250 psi by an inflammable gas. When placed in a cam actuated discharger fixed on the engine, the bulb's sealing cap is pierced, and the fluid is directed through a small distribution line into the engine intake system.

These are the characteristics of primer bulbs as verified during operation Eager Beaver: They were particularly efficient in the temperature range from −10 to −25 F; they withstood hydrostatic pressure of at least 6,000 psi, and temperatures up to 600 F; if accidentally ruptured they split open without exploding flying shrapnel; they discharged fluid at temperatures as low as −65 F; and they can be transported in shipboard, in vehicles or stored with other inflammable materials without danger.

▶ **Arctic Lubricants.** Probably the most satisfying results of this exercise were obtained from studying the arctic lubricants. Although this was the first large scale test under field conditions of the artic anti-freeze, the

GAA grease, and the OES engine oil, all performed so well that no changes are planned in their specifications for the near future.

The anti-freeze is quite unique. It's a premixed solution containing ethylene glycol, distilled or deionized water, borax, and some other constituent (like methoxy-methoxy-ethanol, or cellosole) to assure a freezing point below —65 F, while at the same time raising the initial boiling point to at least 230 F.

The grease is designed to serve as a lubricant in all automotive components except the water pumps. It operates in a temperature range of —65 F to 125 F.

The arctic engine oil was designed as a general purpose, low temperature, lubricating oil for use in internal combustion engines operating in temperatures from —65 to 0 F. However, when temperatures slide below —40 F, the initial flow and pumpability characteristics of OES require special consideration based on design factors in the engine and related accessories. Therefore, the Corps of engineers specifies this engine oil only at temperatures above —40 F.

▶ **Machine Performance.** At the start of the exercise, the artic testers had many breakdowns, mostly of a minor nature, and considerable difficulty in starting engines.

Overall, equipment performed better than expected. However the ERDL scientists picked up many recommendations for design changes as well as verifying design ideas. These are typical.

Tractors. Cab heating and crew comfort provisions proved insufficient and generally unsatisfactory for temperatures below —30 F. Wear of track guides was unusually severe. Bull dozers with cable-operated blades suffered frequent cable breakage and required too many clutch adjustments because snow entered clutches and cause slippage and grabbing.

Motor Graders. Hydraulically-operated—with fluid MIL 0-5605—these machines gave practically trouble-free service. Only discrepancies noted: Below —40 F, crew comfort provisions were ineffective, steering was stiff, and fuel lines froze easily.

Crane-Shovels. One of the few pieces of equipment that satisfactorily provide comfort for crew even at extremes of temperature. Modifications responsible for this included: special cab insulation, forced hot-air heating, coated control levers processed with "Seal-peel" hot-dip to prevent freezing flesh to metal surfaces.

Scrapers. This type of equipment was plagued with part breakage. Increasing cable size from $\frac{1}{2}$ to $\frac{5}{8}$ in. failed to reduce the excessive number of cable failures caused by cold weather brittleness. Fatigue aggravated by the cold was apparently responsible for a large number of body fractures.

MORE ON TITANIUM PROCESS

LAST NOVEMBER, United International Research, Inc., a small Long Island (N. Y.) company, threatened to thow a monkey wrench into some plans to expand titanium-producing facilities. They announced they were applying for a patent on an electrolytic process for refining titanium ore (*Product Engineering*, December 1952, p 196). Metal producers became reluctant to invest heavy capital in equipment for the Kroll magnesium reduction process—currently the only commercial method of turning titanium ore to metal—to produce sponge at $5.00 per lb, if United's process would turn out the same pure sponge at only $1.00 per lb.

Most of the current titanium producers looked into the process, but decided to wait and see when International adopted a "sign up before we reveal the details" attitude.

Now Alfred R. Globus, United's president, reports that their first pilot plant—capacity 50 lb per week—will be completed early in August. According to the present schedule, he expects the new technique should be proved by the first of October.

Globus scoffs at industry gossip that the process won't work. He claims that nobody knows the details except United's top personnel, their patent attorney, and a licensee who is financing this phase of the development.

United, of course, won't reveal details of the process until they have patent protection. But they were willing to explain this much. Their process is similar to the Hall electrolytic refining process for aluminum. Key to its success are three United developments: 1) a special electrode, 2) a special electrolyte, and 3) design of a closed electrolytic cell.

Globus pointed out that there were several significant differences between the Hall process for producing aluminum, and United's process for titanium. These are typical:

- Hall process uses carbon electrodes. United uses a specially compounded electrode because carbon contaminates titanium.
- Hall process uses a sodium fluorite electrolyte. United uses their own composition electrolyte.
- Hall process is a relatively hot process, operating at about 900 C compared to United's technique that runs between 600 and 700 C. Lower temperatures are needed to minimize titanium's appetite for impurities.
- Hall process uses an open electrolytic cell. Titanium, because it combines so easily with so many elements, must be produced in a closed cell, under an inert atmosphere.
- In the Hall process, aluminum dioxide is added in batches. Titanium oxide must be added as it is used up in the cell. Otherwise the sponge will absorb oxygen from the ore.

United scientists claim that their recent seven months development work has failed to turn up a flaw in the orignal process. That's why Globus is so optimistic about predicting quick commercial production with his process.

The pilot plant, under constructio , is actually one commercial titanium producing electrolytic cell. A large scale production plant would have 200 or more of these same cells. Globus says that a commercial installation could be built in 6 months.

Licensing this process gets a little complicated now. Last November, United was looking for licensees to help finance the pilot plant. They signed up an electrochemical equipment builder who wants to remain anonymous. Apparently, his main interest is supplying the electrolytic cells to metal producers already in the field rather than starting a new producer. At any rate United forwards prospective licensees to this company.

If United's process is as good as it is claimed, titanium should be available to almost everybody who wants it in two or three years.

OPTICAL CORROSION STUDIES

USING an interferometer technique to measure corrosion, scientists at the Nation Bureau of Standards are studying the chemical durability of mineral materials like optical glass, porcelain enamel, quartz, natural and artificial silicates, and various metals. With this procedure, researchers have noted corrosion to the depth of as little as one or two ten-millionths of an inch. Such precision is producing new information about materials that are apparently corrosion resistant.

To make an interferometer check, the sample is first ground and polished to optical flatness; it is immersed to half its depth in a corrosive solution; removed, rinsed, and dried; covered with an optical flat piece of quartz; and then viewed through a conventional interferometric apparatus that is illuminated by a helium lamp.

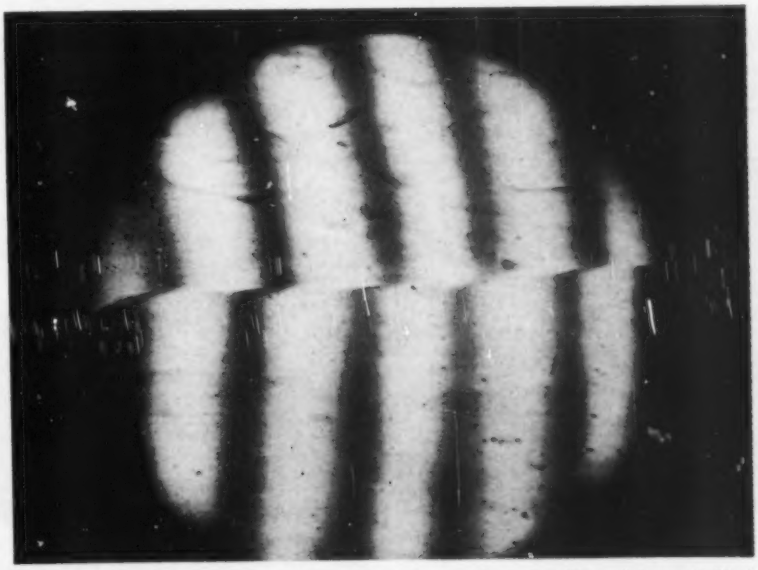
Ordinarily, an observer sees interference fringes as parallel vertical lines. If the corrosive solution has impaired the surface, the vertical fringes are shifted laterally at the point where they cross the line made by the solution, denoting that this section is thinner than the untouched one. If the solution causes swelling of the surface, the shift is in the opposite direction.

A lateral shift equal to the space between two adjacent fringes corresponds to a dimensional change in the specimen amounting to one-half wave length of light, or roughly 0.3 micron (a micron is one millionth of a meter, or about 40 millionths of an inch). NBS researchers are able to measure thickness changes of as little as 0.003 microns.

Most interesting effect noted by the scientists was the swelling observed in many samples rather than attack. These results are typical:

- Crystalline quartz showed definite signs of swelling rather than erosion after two weeks exposure to an 80 C acid solution (pH 4.1).
- Opal swelled considerably when immersed in acid of strength pH 2 to pH 8; but the silica mineral was rapidly attacked by acid when the pH rating exceeded 11.
- Nearly neutral alkaline and acid solutions cause brass to swell, although strong solutions cause rapid corrosion.

USING INTERFEROMETER APPARATUS of the Pulfrich type, scientist measures corrosion of optically flat specimens spotting infinitesimal evidence of attack.

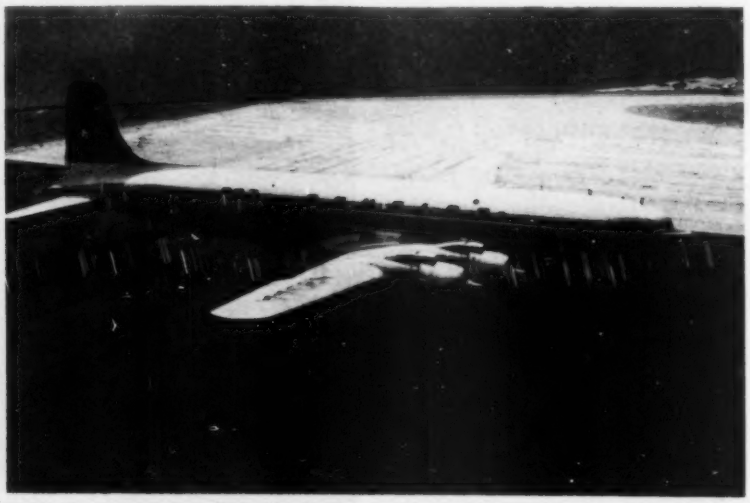


FRINGE PATTERN seen through interferometer eyepiece. Swelling of lower half of sample has caused displacement of fringe pattern to the left about ¼ fringe.

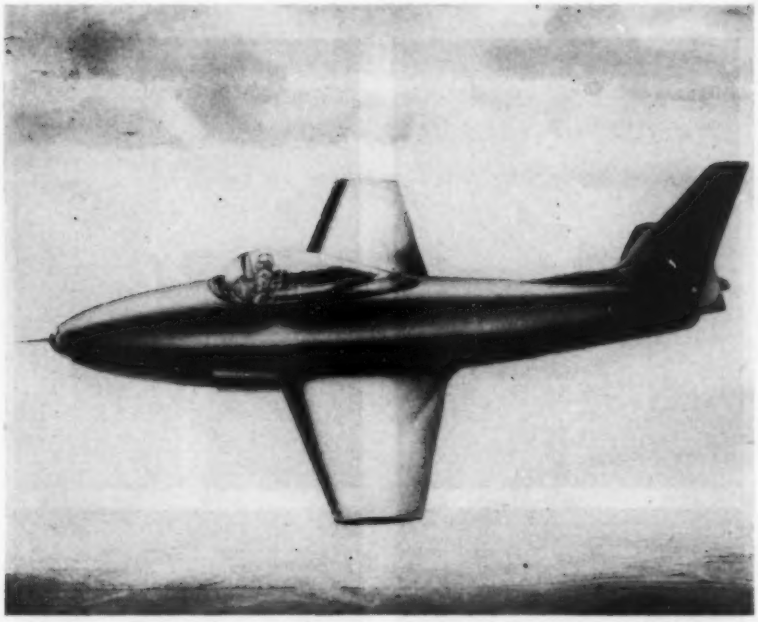
THE NEWS IN PICTURES

SHOCK WAVES CREATED in miniature in this shock tube are being studied by General Electric Engineers to determine the effect of such waves on jet engine combustion processes. Tube consists of two chambers separated by a thin diaphragm; pressure is built up in one while the other is evacuated. When diaphragm is punctured, pressure difference is great enough to send a shock wave the length of the tube at supersonic speeds. Camera equipment at right records the wave for future study.

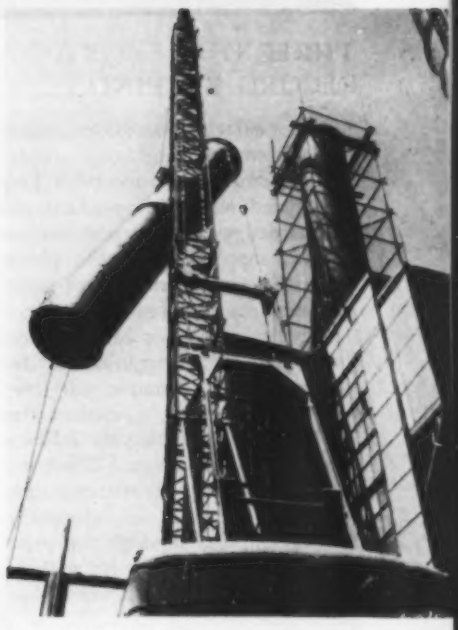
NEW 1,600 hp diesel-electric locomotive standardized by its builders—American Locomotive Co. and GE—to fit railroads throughout the world.



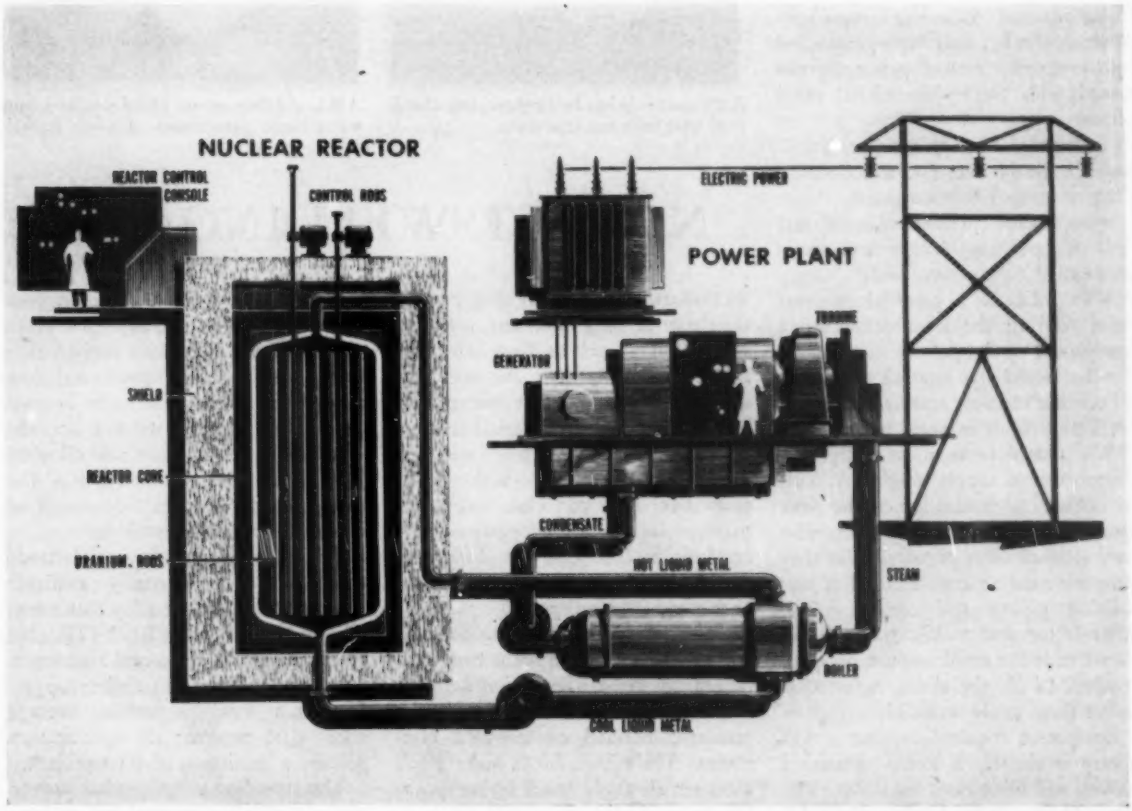
FASTEST piston-powered air liner in the world—according to Douglas Aircraft Company—the new DC-7 recently completed tests in California. Closely resembling the DC-6 series, the new airplane is powered by Wright turbo-compound engines, rated at 3,250 takeoff hp each; cruising speed is 365 mph; top speed 410 mph.



PROPOSED JET TRAINER, designed by Ryan Aeronautical Company for the U. S. Air Force, can use a variety of power plants. Ryan designed this aircraft to use current or future engine designs. In addition, they left enough space in the fuselage to accommodate a single engine or dual engines.



FIRST GLASS-LINED steel smokestack is raised into place. Bonded by A. O. Smith, the glass layers will resist acid condensate in the smoke.



NUCLEAR POWER PILOT PLANT proposed by Atomic Energy division of North American Aviation to generate electricity. Nuclear fission reactor replaces coal or oil fired furnaces in conventional central station systems. North American estimates that their pilot plant will cost $10,000,000 to build; when completed it would generate 8,000 kw. Energy liberated in the pile is absorbed by liquid metal passing through reactor; hot metal turns water to steam that drives conventional turbine generators.

THREE D RECORD KEEPING

THREE DIMENSIONAL PHOTOGRAPHY is the latest technique being adopted by engineering departments to keep easy-to-read records of products and product designs. Users report that perspective supplied by stereo photos makes them more valuable for record purposes than conventional photos.

Giddings and Lewis Machine Tool Co., typical of the organizations that have started 3-D libraries, was interested in developing a method that would speed up digging out information about past designs. The company found that it was relatively time-consuming to extract such information from blueprints, although the prints contained all the data. In addition, the design of a heavy machine tool requires hundreds of drawings, so it would take hours to find the proper drawing or drawings that described a specific feature.

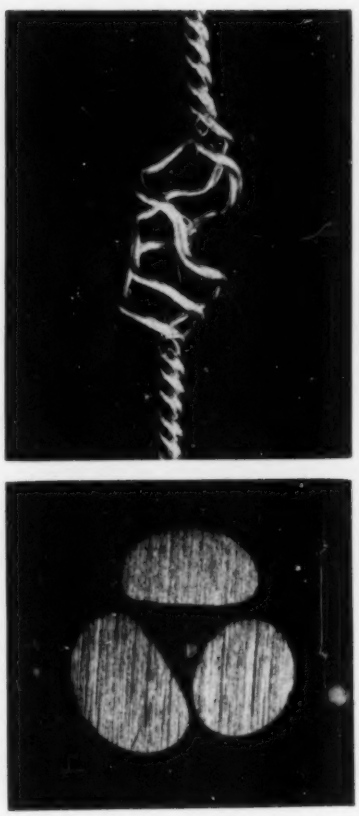
Last year Chief Engineer E. L. McFerren suggested that the company try stereo pictures. An ardent camera hobbyist, McFerren had been impressed by the results he had personally obtained with three dimensional color photography.

Today the company has already collected a file of over 300 stereo slides. They're using 3-D photography:

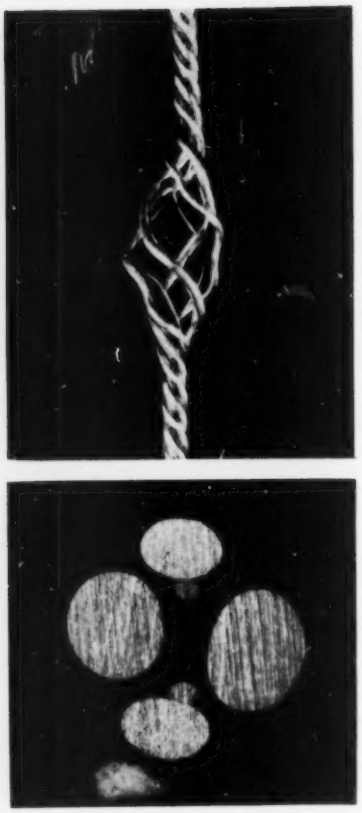
- To obtain three-dimensional records of operating devices and accessories used on machine tools.
- To maintain a pictorial progress report during the construction of a new model or design.
- To record the location of electrical conduit routing, and hydraulic and lubrication lines in their machines.

When used to augment blueprints, stereo photos supply engineers with an instant comprehension of the most complicated structures. Engineers who have studied these pictures claim they offer the most accurate method of visualizing piping and conduit. One other factor that makes 3-D pictures attractive is the small amount of space required to file the slides, a fact that makes them easily accessible.

Equipment required to start a 3-D library is simple: a stereo camera, a viewer, and filing cases for slides. The photo finisher, who develops the color film also binds the three dimensional photographs into slides that fit the viewer and the filing cases.



A101 electrode has two copper, one aluminum wire with fine iron core.



A161. Adding second aluminum and iron wires boost percentages of those metals.

NEWEST WELDING IDEA:

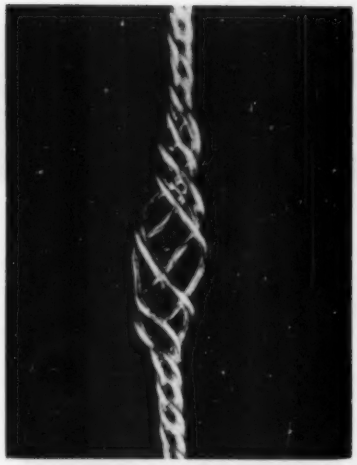
IN THE INERT-GAS arc welding process, the electrode, long filler wire, is usually wound on a reel so that it can be fed continuously into the weld by a motor drive. To date the process has been limited to materials that are ductile enough to permit winding. Many special materials—with specific properties like corrosion resistance, hardness, or bearing properties—have not been used because it is difficult to fabricate them in small diameter wire or to wind them on spools.

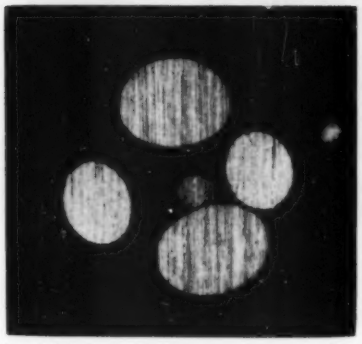
At the American Welding Society's annual meeting last month, two engineers from the Air Reduction Research Laboratory reported a solution to the problem: braided or stranded electrodes. Their basic idea: make small diameter electrode wires by compositing the ductile elements.

To develop an aluminum bronze electrode—(a popular alloy for overlaying and joining applications but with no ductility when aluminum content exceeds 10 percent)—the engineers stranded electrolytic copper, electrical conductor aluminum and low carbon steel wire. When the braided wire is melted in a welding arc, the elements thoroughly mix and alloy together. Chemical composition of the final alloy depends on the amount of material supplied in wire form.

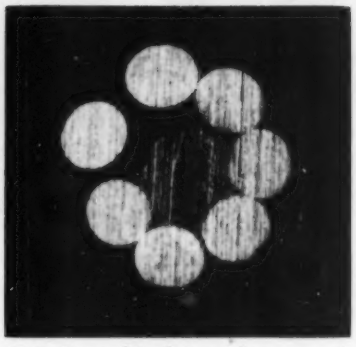
For example, composite electrode A101, now commercially available from Airco, forms an alloy that meets ASTM specifications B225-52T. It's composition is 9.25 percent aluminum, 1.0 iron, and the remainder copper. Maximum total impurities average about 0.05 percent; the specification permits a maximum of 0.60 percent.

The stranding technique has proved to be a flexible method of making electrodes. Its possible to change from manufacturing one alloy to another by drawing the individual wires to proper





A190. Two aluminum, two copper and a thicker iron core alter composition.



A170. Core of lead-tin solder surrounded by copper wire strands in new electrode.

BRAIDED ELECTRODES

diameter and setting the stranding machine for the predetermined design. It's economic enough to justify limited production. Now Airco has available three types of bronze aluminum electrodes and one lead-tin-copper bearing alloy.

Welds made with stranded electrodes appear to have strength comparable to welds made with solid metal electrodes of the same composition. The joint strength developed in steel is equivalent to that developed by some of the mild steel electrodes. The deposits also provide good bearing surfaces when used to overlay steel parts subject to sliding friction.

Major advantages of the new materials are those associated with the use of inert gas arc welding instead of metal arc welding. They include: (1) increased overall deposition rate; (2) increased deposition efficiency; (3) reduction in loss of alloy elements; (4) lack of surface flux and entrapped flux materials; and (5) smooth and uniform bead surface.

In one application—aluminum bronze overlays on piston-recoil sleeves for an artillery gun—the use of stranded instead of coated electrodes tripled production. The fabricator also reported a better quality weld and a reduction of electrode material from 6 lbs of coated electrodes to 2½ lb of stranded wire per sleeve.

For the future, the researchers feel that stranded electrodes have their biggest future in joining steel copper, nickel, aluminum bronze manganese bronze, and copper and nickel base alloys. The unique corosion resistance of the deposit may make it useful in the fabrication of processing equipment for the chemical industry. In addition, alloy A170 displays properties that may make it useful as a bearing material.

ELECTRONS TOUGHEN PLASTICS

ENGINEERS AND SCIENTISTS working in electronics seem to delight in developing new and unique methods of using the versatile electron. Last month, General Electric researchers announced a new list of startling chemical changes brought about by electronic action. At GE's Schenectady Laboratory, scientists found that brief bombardment by electrons would:

- Toughen polyethylene plastics so that containers made of such materials can withstand steam sterilization.
- Turn certain liquid substances into solids at temperatures as low as —100 F.
- Lower the molecular weight of (depolymerize) natural products like wood and cellulose.
- Sterilize bread, vegetables and other foods so they remain fresh over relatively long periods of time.

Toughening of polyethylene apparently results from a forced chemical change. Bombardment, even for a few seconds, causes the chain-like molecules to cross link. This structural weaving not only increases the resistance of the plastic to temperature but also improves its resistance to the corrosive action of some solvents.

GE currently is converting the research discovery into a commercial process. They feel it will open up many new applications for polyethylenes. Typical new use: containers for pharmaceuticals including blood plasma. In the past these have been packaged in glass because the containers had to be steam sterilized. Ordinary polyethylene containers collapsed when subjected to such temperatures.

By controlling the pattern of an electron beam bombarding liquid plastics, laboratory chemists found that they could solidify those portions exposed to the beam. GE scientists feel that this may suggest new methods of casting and forming plastic articles. It could also result in stronger products.

The depolymerizing experiments have not as yet turned up any industrial applications so far; they are still only scientific curiosities. For instance, bombarding wood with electrons disrupts the ligning-cellulose complex of the wood so that bacteria in any animal's stomach can digest the cellulose as adequate nourishment in lieu of conventional foods.

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Increase Life of Spin Dry Motor from 3 months to more than 4 years

Take a tip from a guy who had to pay for motor failure out of his own pocket. That guy started out in a basement with the best second-hand laundry equipment he could afford.

In that highly competitive business, the going was tough for both man and machines. The man could take it because he was no ordinary guy. But the 6 hp, open-frame, fan-cooled Class B motor on his largest dryer couldn't take the heat and humidity. Mounted directly above the open spinner bucket and plugged to stop quickly after each 15 minute cycle, that motor failed 4 times in the first critical year.

Each failure cost 5 days in down time; made it necessary to operate the smaller dryer 20 hours a day to meet delivery dates. With no margin to play with, our friend had his 6 hp motor rewound with Class H insulation. That was four years ago. The motor is still working, and the Blue Ribbon Laundry has become a successful business in Battle Creek, Michigan.

In these days of good solid competition, no one can afford needless down time. Class H insulation costs relatively little more than the next best class of insulating materials, and it makes your motors last 10 to 100 times as long as they ever did before. Or you can use Class H to double the power per pound ratio in electric machines.

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Chart for Determining Load and Life of Ball and Roller Bearings

Saves interpolation and calculation for operating conditions that fall between the values listed in manufacturers' catalogs.

LeROY S. HARRIS
Consulting Engineer

IN MOST ball and roller bearing applications, the load, speed and life conditions required for design purposes are not identical to any one of the corresponding sets of conditions listed in the manufacturers' catalogs for their different bearings. For example, the catalog may list loads for their bearings at speeds of 2,000 rpm, 3,000 rpm, 4,000 rpm, and 5,000 rpm. The operating speed in a given application may be 4,500 rpm. Under these conditions, the designer must calculate the corresponding values for load, speed, and life for the particular ball or roller bearing application being considered. Although the method of calculation and the factors that are required are usually contained and explained in the manufacturers' catalogs, the corresponding values of load, speed and life can be determined more easily and more readily by graphical means with a Load-Life chart.

This chart, Fig. 1, is for bearings that are rated according to the classical bearing-life equation $L_N = (C/P)^3$, in which the life of the bearing varies inversely with the cube of the applied (equivalent) load. This includes the products of many manufacturers. For example, SKF, Kaydon, Torrington, MRC, Fafnir, and Norma-Hoffman. It does not include New Departure, Timken and other manufacturers who rate their bearings with an exponential factor other than the cube. If there is any question about the practice a given manufacturer uses, the method of rating can usually be found in the preliminary or engineering sections of his catalogs or by writing the company.

The procedure for using Fig. 1 consists of finding the specific dynamic capacity of the ball or roller bearing, and then using the specific dynamic capacity and any two of the three conditions (load, speed and life) to find the third. In those applications where the specific dynamic capacity is not listed in the catalog, the specific dynamic capacity can be found graphically from the chart, using any three corresponding conditions of load, speed and life that are listed.

Example 1:

Determine the bearing specific dynamic capacity for the following conditions that were taken from manufacturer's catalog for a particular bearing: 4,000 lb load, 3,000 rpm, and 2,000 hr minimum life.

(1) Locate the intersection of the vertical 2,000 hr minimum life line and the diagonal 3,000 rpm line in the speed-life graphical field.

(2) Project this intersection point horizontally to the right to the vertical 200 hr minimum life line. See dash-line on chart.

(3) Locate 4,000 lb along the Equivalent Load Scale.

(4) Construct Line I between points located in steps (2) and (3).

(5) Specific dynamic capacity value of 28,500 lb is obtained by reading the value at the intersection of Line I and the Specific Dynamic Capacity Scale.

Example 2:

With the specific dynamic capacity given or found as in Example 1, determine the life of the bearing in an application having an equivalent load of 5,800 lb, and operating at 4,500 rpm. The specific dynamic capacity is 28,500 pounds.

(6) Locate the 5,000 lb equivalent load along the Equivalent Load Scale of the charts.

(7) Locate 28,500 lb along the Bearing Specific Dynamic Capacity Scale.

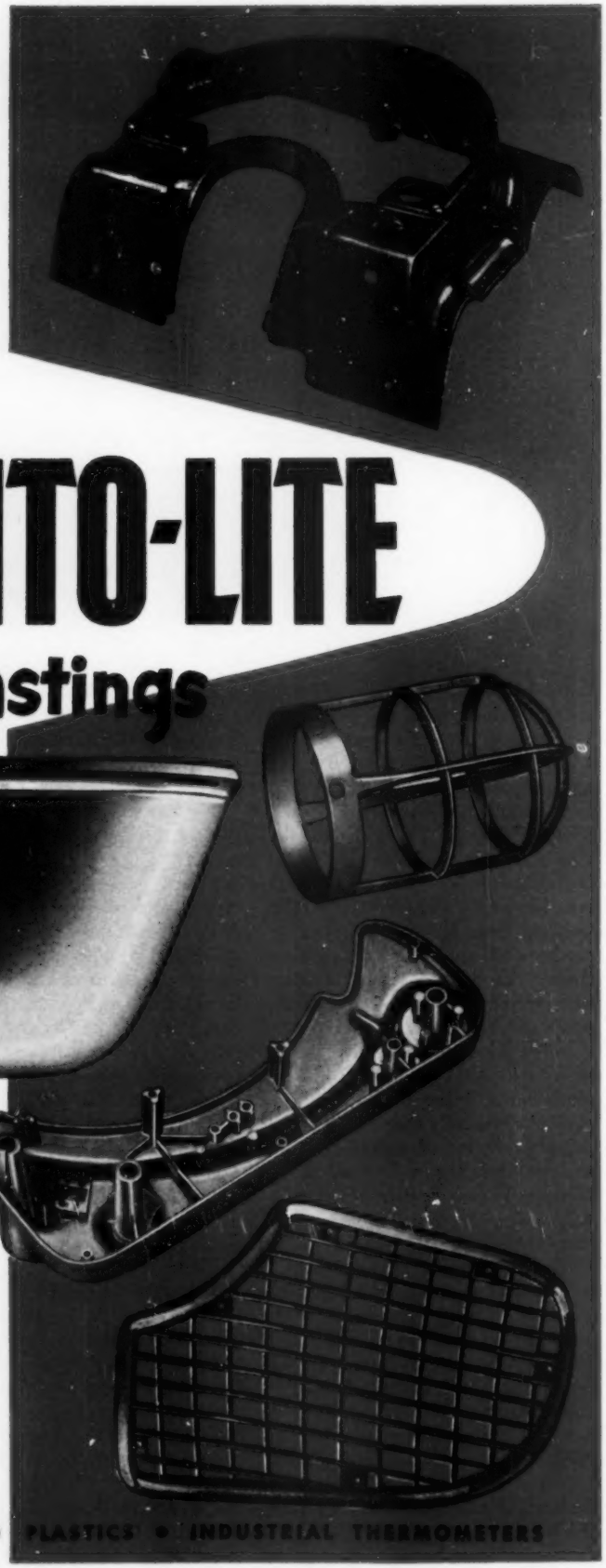
(8) Construct Line II through the values located in steps 6 and 7, extending it to intersect the vertical 200 hr minimum life line.

(9) Project the intersection point found in step (8) horizontally until it intersects the diagonal 4,500 rpm speed line (see dotted line).

(10) The minimum life value of 680 hr is then obtained for the particular application and bearing being considered, by reading the value at the intersection point found in step (9) with respect to the vertical life lines and the Minimum Life Scale.

(continued on page 213)

You're always right with AUTO-LITE Die Castings



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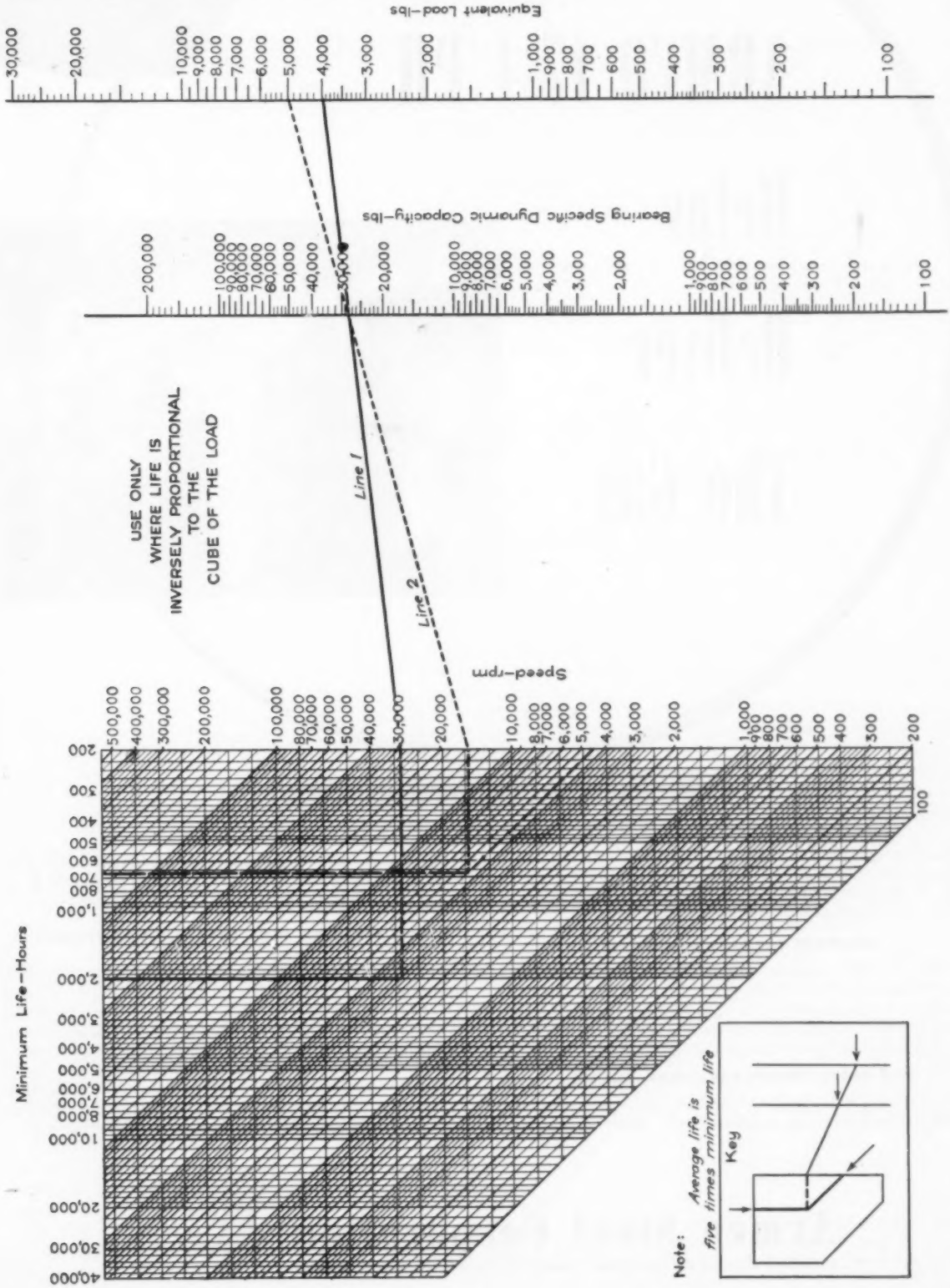
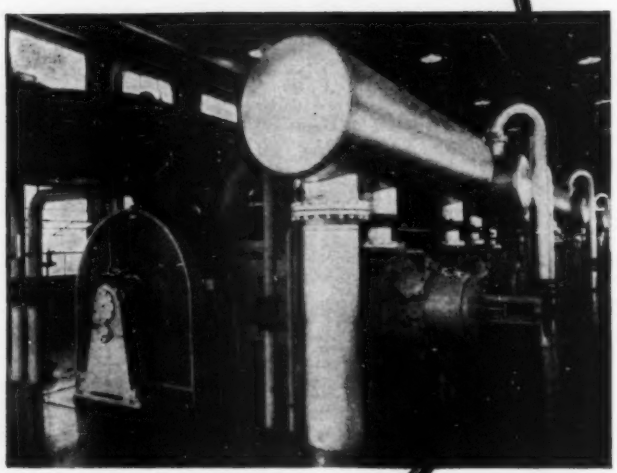
Determining Load and Life of Ball and Roller Bearings (continued)



ARMCO 17-4 PH Helps Deliver The Gas



This large hoop is a vital part of a large gas compressor. As a piston ring expander it must exert continuous pressure on the piston ring. The ring is made of Armco 17-4 PH, a new precipitation-hardening stainless steel.

HARDENED WITHOUT DISTORTION

Armco 17-4 PH requires only a single low-temperature heat treatment at 850-900 degrees F. There is no distortion, cracking or scaling—only a light heat tint. Yet the heat treatment develops a minimum tensile strength of 180,000 psi and minimum yield strength of 165,000 psi.

TWO PRECIPITATION-HARDENING GRADES

Armco 17-4 PH is produced in bars and wire. Another precipitation-hardening stainless steel, made in sheets, strip, plates, bars and wire, is known as Armco 17-7 PH. Depending upon condition, this grade is hardened by a single or double low-temperature heat treatment.

HIGH STRENGTH PLUS CORROSION RESISTANCE

Both precipitation-hardening stainless steels develop yield strengths higher than Types 301, 403, 410, 414, 416 and 431, with equal or higher tensile strengths. Yield strengths in compression are equal to or higher than those in tension. Corrosion resistance of both grades is generally better than that of the standard hardenable types.

If you want the latest information and test data on these remarkable stainless steel grades, write for the bulletin, "Armco Precipitation-Hardening Stainless Steels."

Armco Steel Corporation

3823 Curtis Street, Middletown, Ohio • Export: The Armco International Corporation

Calculating Design Data from Sample Gears

Provides a means of reproducing design data for gears from a broken segment or for producing replacements for worn gears of unknown origin.

ALFRED BISHOP
Wright Aeronautical Div., Curtiss-Wright Corp.

THIS SIMPLE METHOD of calculating basic design data from a gear of unknown origin requires only two micrometer measurements, taken across consecutive numbers of teeth. It yields the base diameter of the gear plus the circular tooth and circular space thicknesses at the base diameter. From these—and the number of teeth, all other pertinent data can be calculated.

The basis of this method is that (1) a perpendicular to an involute curve at any point is tangent to the base circle from which the involute was produced and (2) a straight line tangent to the base circle and extended to the involute is exactly the same length as the arc of the base circle from the point of tangency of the straight line to the base of the involute. Hence, a measurement taken with the flats of a micrometer or similar instrument, tangent to the involutes of the two teeth contacted is exactly equal to the length of arc subtended by the involutes from which the measurement was taken.

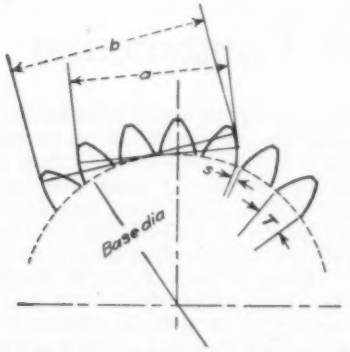


Fig. 1—From micrometer measurements across two consecutive numbers of teeth such as *a* and *b*, the tooth thickness and space thickness at the base circle can be calculated with Eqs (3) and (4) which are given in the text.

Table I—Suggested Measurements for Various Tooth Numbers

No. teeth between measurements	2	3	4	5	6	7	8	9
Pressure angle, deg	No. teeth in gear							
14.5	12–25	26–37	38–50	51–62	63–75	76–87	88–100	——
17	12–21	22–32	33–42	43–53	54–64	65–74	75–85	86–97
20	12–18	19–27	28–36	37–45	46–54	55–63	64–72	73–81
22.5	12–16	17–24	25–32	33–40	41–48	49–56	57–64	65–73
25	12–14	15–21	22–29	30–36	37–43	44–51	52–58	59–66

A limitation of the method is that pinions of a small number of teeth cannot be calculated, since it will be impossible to measure across the involutes of three teeth, the minimum required. In general, however, measurements across any two consecutive numbers of teeth, excluding one as impractical, will be satisfactory. Also, if the gear or pinion is badly worn, it may be necessary to add an estimated or measured excess backlash to the measured value.

EXAMPLE: In Fig. 1, let

- a = distance across 4 teeth and 3 spaces
- b = distance across 5 teeth and 4 spaces
- t = arc tooth thickness at the base circle
- s = arc space thickness at the base circle

Then:

$$a = 4t + 3s \quad (1)$$

$$b = 5t + 4s \quad (2)$$

Solving these equations simultaneously,

$$t = 4a - 3b \quad (3)$$

Substituting n for the number of teeth in the distance a,

$$t = na - (n - 1)\,b \quad (4)$$

Similarly

$$s = nb - (n + 1)\,a$$

The base circle pitch $= (t + s)$, and if N is the number of teeth in the gear,

$$\text{Base Circle Dia.} = \frac{N(t+s)}{\pi} = \frac{(b-a)\,N}{\pi}$$

With the base pitch and base circle diameter, a diametral pitch can be selected that will satisfy the known factors of the gear. If the gear is standard, i.e., the tooth thickness equals the tooth space at the pitch diameter, the PD can be determined as follows: Place wires of a diameter equal to one half the base circle pitch between the gear teeth as shown in Fig. 2. The centers of these wires coincide with the pitch diameter. The PD can be evaluated by subtracting the wire diameter from the over-wire diameter.

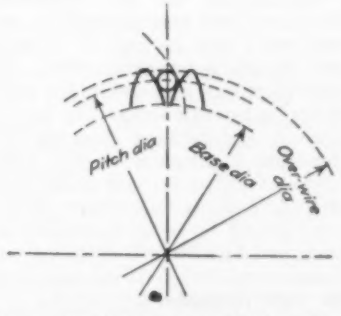
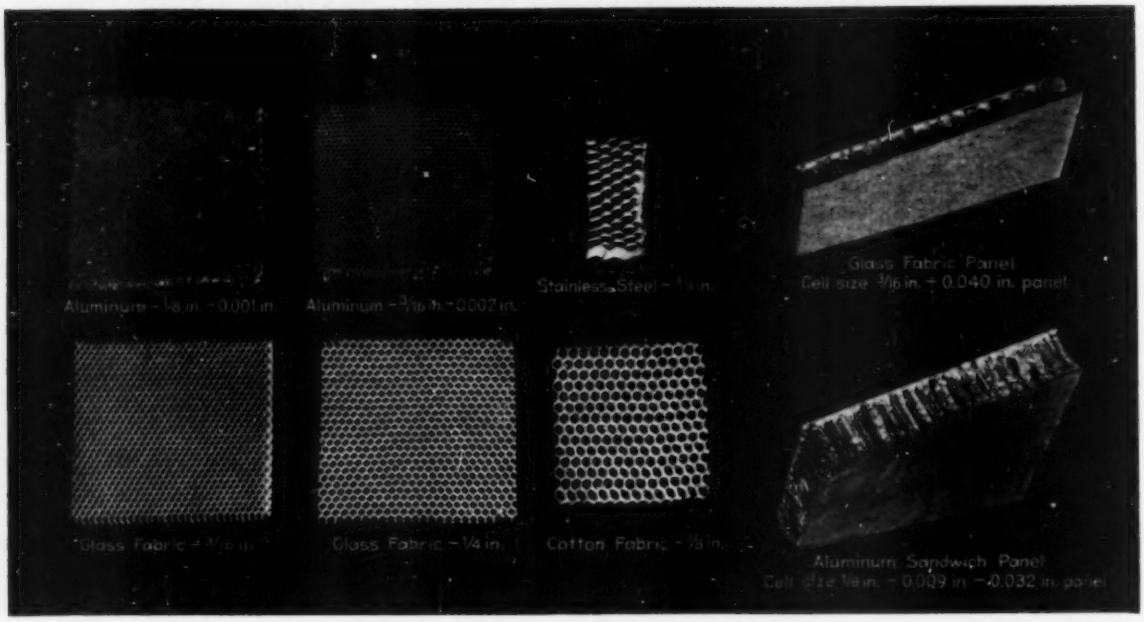


Fig. 2—Sketch shows that a wire of diameter equal to one half the base pitch will have its center on a radius at which the tooth thickness and space are equal.


Aluminum - 1/8 in. - 0.001 in.
Aluminum - 3/16 in. - 0.002 in.
Stainless Steel - 1/4 in.
Glass Fabric Panel
Cell size 3/16 in. - 0.040 in. panel
Glass Fabric - 1/4 in.
Cotton Fabric - 1/8 in.
Aluminum Sandwich Panel
Cell size 1/4 in. - 0.009 in. - 0.032 in. panel

VARIOUS TYPES OF honeycomb structures, including two aluminum and two glass fabric materials. The measurements given refer to the distance across the flats of the hexagonal shaped cell. The additional measurement under the aluminum structures refer to the thickness of the metal. A plastic and aluminum sandwich panel are shown at the extreme right. For any given bonding procedure, the substitution of $\frac{1}{4}$ in. cell honeycomb for $\frac{1}{8}$ in. cell honeycomb will increase the skin bond strength. The small cells also aid in preventing premature dimpling of thin skins under compressive loads.

Structural Honeycomb For Sandwich Construction

Honeycomb core materials of aluminum, glass fabric-plastic, cotton fabric, stainless steel, and high temperature materials are now available in cell sizes ranging from $\frac{1}{8}$ to $\frac{3}{8}$ in. for aluminum and fabric, and up to $\frac{3}{4}$ in. for stainless steel. With this material, the user can cut and make his own faced sandwich structure.

Applications for the aluminum honeycomb have been primarily in aircraft where they are used for primary and secondary structural units, and other parts such as ailerons, fins rotor blades, and missile wings. The honeycomb is manufactured from 3S-H19 aluminum in densities ranging from 1.6 to 8.1 lb./cu. ft., and in cell sizes of $\frac{1}{8}$, $\frac{3}{16}$, $\frac{1}{4}$, and $\frac{3}{8}$ inch. Other dimensions are: up to 30 in. wide; 100 in. long; and 24 in. in cell depth. A tolerance of ± 0.005 in. is maintained on the depth dimension.

The small sizes are recommended for most aircraft applications, with the $\frac{1}{8}$ in. cell giving almost a 100 percent bonding area. The adhesize used is a vinyl-phenolic resin.

Honeycomb for contoured or tapered parts can be made by forming the expanded aluminum honeycomb core to the approximate curvature desired, with sheet metal forming rolls, and using preformed skins to fabricate the panel. This procedure can be simplified in some cases by bonding the core to one skin before forming.

Stainless steel honeycomb is made in two cell shapes, in three cell sizes, and in three alloys, and is suitable for use at temperatures from 350 to 1000F. A resin bonded core is made in $\frac{1}{4}$ and $\frac{3}{8}$ in. cell sizes and a square cell using a resistance welded bond is available in $\frac{1}{4}$, $\frac{1}{2}$, and $\frac{3}{4}$ in. cell size. The highest operating temperatures can be obtained by brazing with nickel-chromium alloys such as Nicrobraz, which contains boron.

Glass Fabric honeycomb sandwich structure weight, under some loading conditions, will run 10 to 20 percent lower for the same strengths than a similar structure of other core materials. The glass fabric honeycomb is produced in either block form or pre-sliced with densities ranging from 2.5 lb./cu. ft. to 10 lb./cu. ft. Block sizes are approximately 40 to 70 in. in length by $7\frac{1}{2}$ to $8\frac{1}{2}$ in. in width by 17 in. in depth. Cell sizes are $\frac{3}{16}$, $\frac{1}{4}$, and $\frac{3}{8}$ inch.

All glass cloth used has the 14 finish required for aircraft applications; 108 cloth is used in the lightest core which weighs 2.5 lb./cu. ft., and 112 cloth is used in all straight polyester cores.

A heat resistant core, type CTL, is available in the three cell sizes. At an 8 lb. density, this core has a 600 psi compressive strength after one hour at 600 F. Uses are as a radome material, structural applications, and for sharply precurved sections.

Sandwich Constructions For Elevated Temperatures

Temperature Deg. F	Core	Facings	Skin Bond	Comments
Up to 350	Aluminum	Aluminum	Resin	A suitably bonded aluminum honeycomb sandwich will retain three-fourths of its strength at 300 F., and about two-thirds of its strength at 350 F.
Up to 500	Special Glass-Plastic	Laminates Steel or Titaniun.	Resin	A glass-fabric honeycomb made with heat resistant resins shows good strength at 500 F. Some resins begin to deteriorate after a few hours at this temperature.
300 to 600	Steel	Steel, Titanium or Laminate	Resin	This construction is dependent on high temperature metal adhesives. A top limit approaching 700 F. may be feasible.
350 to 1000	Steel	Steel or Titanium	Brazed or Welded	Permissible operating temperatures will depend on the brazing compound, the alloy, and its condition. The silver brazing alloys have an upper operating limit of about 850 F.

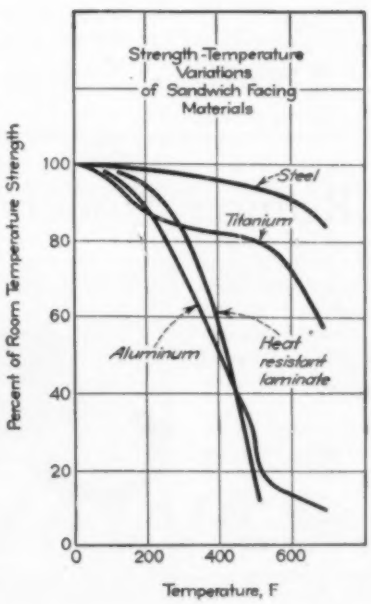
A large block of ¾ in. cell size cotton honeycomb. The fabric is 4 oz. cotton and is impregnated with phenolic resin. Although less expensive than glass fabric honeycomb, it has good strength properties.

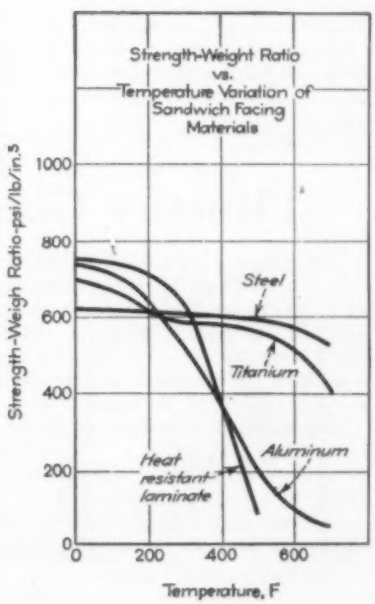
The cotton core materials are made in one $\frac{7}{16}$ in. cell size using both 8 oz. and 4 oz. cotton fabrics. They weigh approximately 8 lb./cu. ft. and 4.5 lb./cu. ft. respectively. Compressive strength for the 4 oz. material is 375 psi, and 1000 psi for the 8 oz. material. For a $\frac{7}{16}$ in. cell size using a 4 oz. cotton fabric and having a density of 4.5 lb./cu. ft., the transverse shear strength is 8 psi, and the longitudinal shear 160 psi.

The honeycomb cores are produced at a density of approximately 3 lb./cu. ft., and are then dipped to the desired density in polyester resin.

There are four thermoset adhesives generally used in aluminum sandwich construction; they are: solvent solution varnish type (liquid); cloth supported B stage resin type (tape); unsupported B stage resin type (film); 100 percent solids resins (liquid).

Hexcel Products Co., 955 61st Street, Oakland 8, Calif.





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Automatic, Centralized Lubrication Pumping Unit

An automatic pumping unit, designed primarily as a centralized lubrication system for single machines, dispenses either oil or grease in accurately metered amounts, and requires no attention except for the renewal of the lubricant supply in the reservoir. All parts, including the ¼ hp motor and the V-belt drive unit are mounted on one bedplate, and the unit may be located at any convenient place.

In addition to the model DC-20 central pumping unit, the complete system consists of two main supply lines, a Dualine measuring valve, made by this company, for each bearing, and the discharge line connections from the measuring valves to the bearings. The two main supply lines form a complete loop or circuit, starting from the outlets marked Discharge Line 1 and Discharge Line 2 and returning to the inlets marked Return Line 1 and Return Line 2. The dualine valves can be inserted directly in the supply line loop or connected in parallel with the main lines through risers.

The pumping unit directs the flow of lubricant into first one and then the other of the two main supply lines while the idle line is in relief back to the reservoir. Lubricant pressure at the return end of either main supply line automatically shifts the slide valve piston, built in the base of the pump, to the opposite end of its bore, directing the pump delivery into the other main supply line.

By locating the pressure control at the return ends of the main supply lines the lubricant must first pass through the entire system and develop sufficient pressure to operate all dualine valves before the slide valve will function to redirect the flow into the other main line. This method insures that sufficient operating pressure will be developed regardless of changes in ambient temperature or in the consistency of the lubricant used in the system. To insure proper pump priming under all operating conditions, a grease no heavier than No. 1 N.L.G.I. consistency is recommended.

The frequency of operation of the system is controlled by an electric time switch which gives an adjustable means of starting the motor of the pumping unit. Two electrical limit switches located in the lower section of the pump base

assembly are actuated by the movement of the flow shifting piston to disconnect the pump motor after the requirements of the system have been met.

The unit is powered by a ¼ hp a-c motor, 60 cycle, 1,750 rpm through a 3 to 1 ratio V-belt drive. At this motor speed, the pump delivery rate is approximately 1.5 fluid ounces per minute. Either a single phase or a three phase 25, 50 or 60 cycle motor can be used.

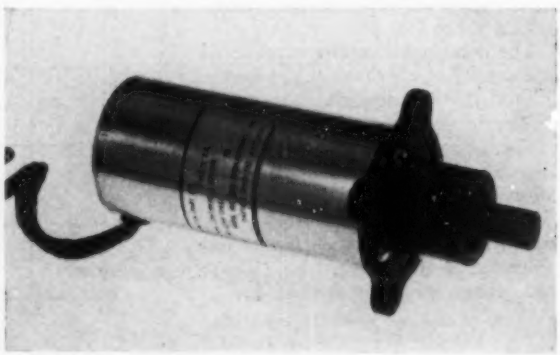
The Farval Corp., 3249 East 18th St., Cleveland 4, Ohio

Planetary Gear Reducer Mounts on D-c Motor

The planetary gear reduced motor shown in the illustration is a combination of a permanent magnet d-c motor made by this company, and a system of planetary gearing designed for maximum output in the smallest possible space. The planetary gear system is designed to mount directly on the d-c motor, and may be supplied with either a 1/100 or a 1/50 hp motor.

The planetary is available in 18 different ratios between 17.8 to 1 and 21,808 to 1. The torque available will vary with the reduction up to a maximum continuous torque of 1,000 oz-in. for the higher ratios.

The unit has a $\frac{5}{16}$ in. dia. shaft extension ½ in. long, and can be supplied for voltages from 12 to 85 volts d-c.



Globe Industries, Inc., 125 Sunrise Pl., Dayton 7, Ohio

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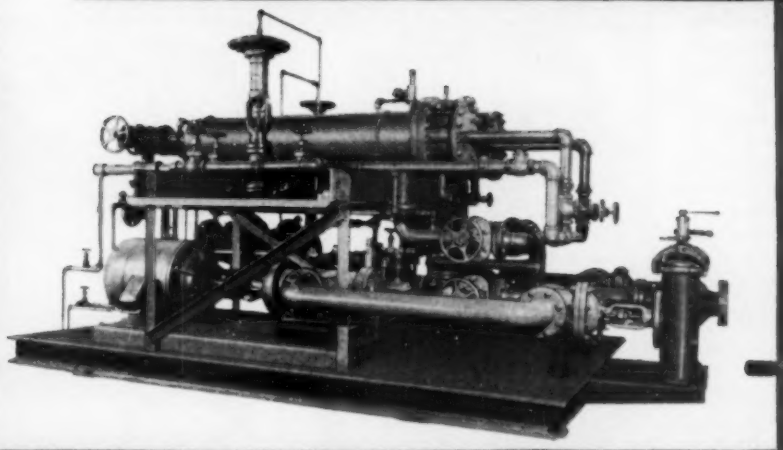
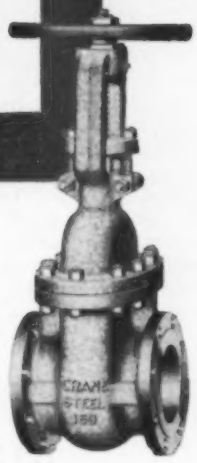
HOW TO HANDLE HEAVY FUEL OIL





another successful product design with piping equipment by CRANE

A lot of design engineering skill and manufacturing know-how went into this fuel oil pre-heater and pump set by National Airoil Burner Company, Philadelphia, Pa.

The set delivers 3,000 gallons of heated fuel oil per hour at 160 PSIG and 200° F. for a large Midwestern oil refinery. Crane valves and fittings were used throughout. Steam lines are equipped with brass valves; oil lines have Crane steel materials.

This is the kind of designing that's made easier with complete piping data right at hand. No wonder more and more successful designers turn first to their Crane Catalog. They know from experience that Crane not only provides the biggest and best selection, but complete facts as well—sizes and dimensions, temperature and pressure ratings, plus details on design materials and construction. And even more important, with Crane quality equipment, they assure machinery buyers of added value and greater dependability.

Crane 150-Pound Cast Steel Wedge Gate . . . An unusually rugged valve, available in carbon or alloy steels, with a variety of trim materials for oil, oil vapor, steam, water, or air. Flanged, welding, or screwed ends; all sizes. Three full pages of specification data in your Crane Catalog.

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CRANE VALVES

CRANE CO., *General Offices:* 836 S. Michigan Ave., Chicago 5, Illinois
Branches and Wholesalers Serving All Industrial Areas

VALVES • FITTINGS • PIPE • PLUMBING • HEATING

Rotary Motor-Pumps For Vacuum and Pressure

Said to be the only dry-air pumps to contain an oil-free principle of operation, these pumps are complete motor-pump units that are adaptable to a process or a machine requiring vacuum, pressure, or a combined vacuum and pressure. Evacuation to 20 in. of mercury suction, or pressurizing to 10 psi can be continuous.

The pump is of the positive displacement type, and operates dry. Carbon-graphite composition blades and thrust plates are self-lubricating. The pump rotor and four sliding blades are the only moving parts and they take up for wear automatically. No seals or packings are used. Pump impeller parts are assembled on the end of the shaft, using no pump bearings.

The line consists of six sizes based on a free air capacity of 0.5, 1, 1.3, 2.6, 4, and 5 cu ft per minute. The motors are wired for 115-230 v, 60 cycle, at 1,725 and 3,450 rpm.

Other features are: oil-free air vapor; less mounting space required; no belts or lubricators; operates without attention for long periods of time.

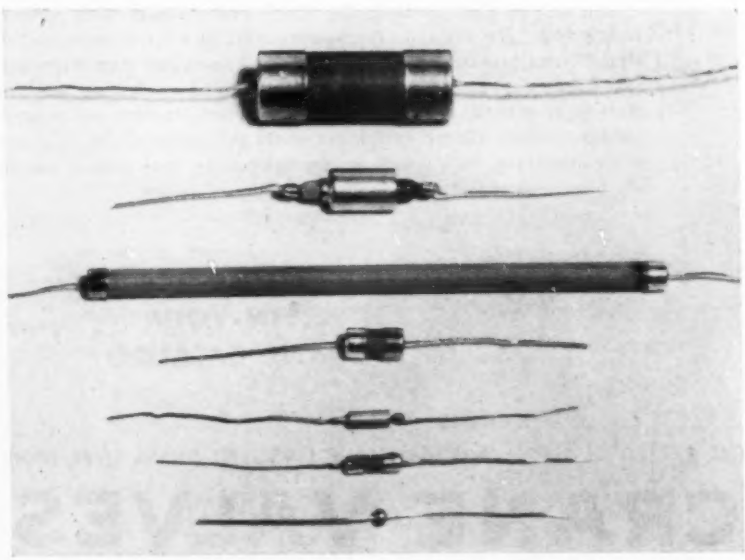
Lear, Inc., Romec Div., 1430 Abbe Road, Elyria, Ohio

Miniature Selenium Rectifiers

Designed as non-expendable components for industrial and government equipment, a new line of miniature selenium rectifiers, ranging from $\frac{3}{32}$ to $\frac{15}{32}$ in. in diameter, will operate small relays, solenoids, and precipitators. Circuit applications include: electronic, blocking, computer, signal, magnetic amplifier, communication, and control.

The assemblies have an ambient temperature range of —55 C to +100 C. At an ambient temperature of 35 C, the single-stack rating ranges from 0.5 ma d-c at 26 volts rms to 25 ma d-c at 5,200 volts rms.

The small-size rectifiers are mounted without spacer washers, as there is no center mounting hole. Two totally enclosed types of castings are available: Textolite tubes for normal industrial operating conditions; and hermetically sealed, metal-clad casings to meet government specifications. Although standard design is for lead mounting, the cells also may be bracket mounted.



General Electric Co., 1 River Rd., Schenectady 5, N. Y.

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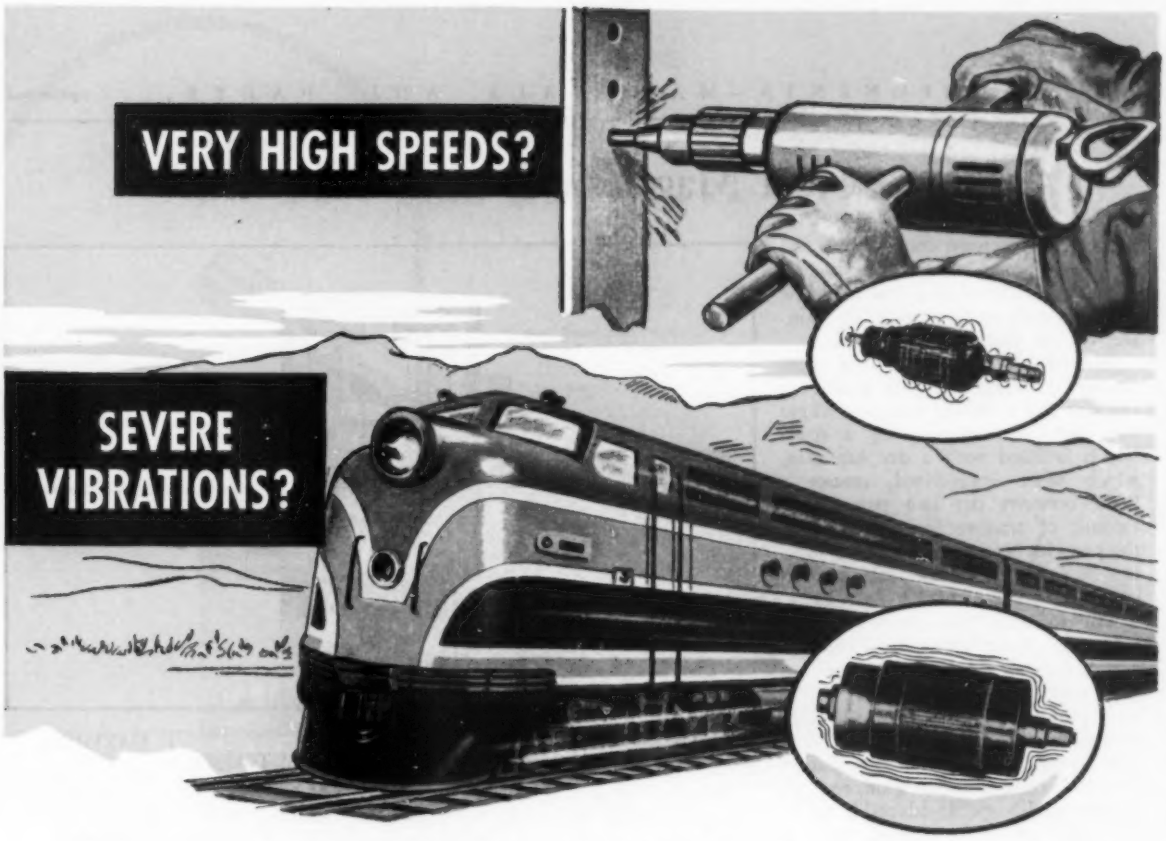

Impregnate Your Windings with this *new, high bonding strength* varnish...IRVINGTON NO. 140

Lab tests prove it—field studies confirm it! The bonding strength of Irvington No. 140—even at Class "B" temperatures—*far exceeds* that of any other varnish developed or tested by Irvington.

Irvington No. 140 prevents coil or wire movements even on units operating at extremely high speeds or under severe vibration. In addition, it has high resistance to heat, oil and chemicals; excellent electrical properties; unusual stability in storage and dip tanks.

Use Irvington No. 140 on high-speed tool armatures, automotive armatures, Diesel electric traction motors and generators, high-speed motors and generators. Fill out the coupon for further facts.

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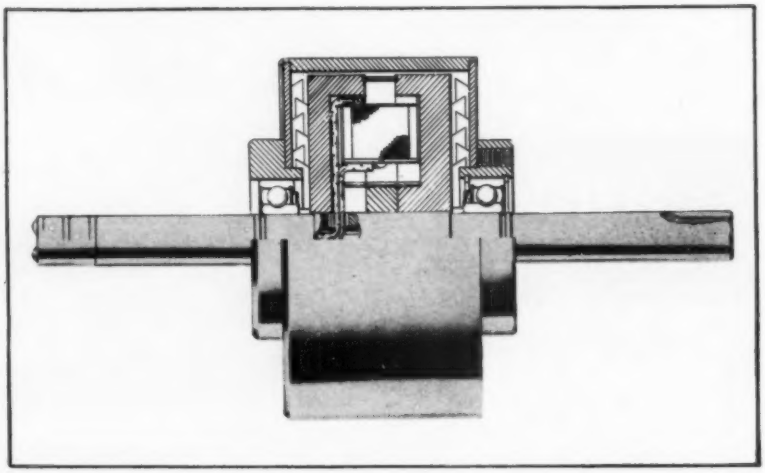
Stainless Steel Magnetic Particle Clutch

Smooth, precision controlled transmission of power with no grab or chatter are the features of a new magnetic particle clutch using particles of stainless steel in place of iron particles.

The clutch consists of two independent rotating members, a driving element and a driven element. These two parts are separated by a space which is filled with a dry lubricant, which when magnetized, creates a bond between the two parts. The amount of tractive force exerted by the particles between the rotating parts can be infinitely varied from zero to complete engagement.

The manufacturers claim that the advantages over conventional clutches and brakes are: continuous operation with negligible wear; releases freely and positively; constant or variable torque output from constant or variable speed input; current excitation accurately controls modulation, engagement and slip speed; adaptable to remote or automatic control; and it operates as a clutch, brake, or in combination in either direction.

The Clark Mfg. Co.,
1830 *E. 38th St., Cleveland* 14, *Ohio*

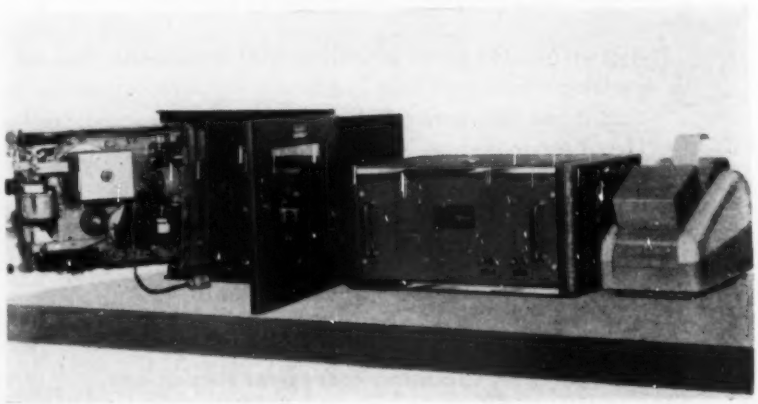


SIZE	TORQUE RANGE	CURRENT AT MAXIMUM TORQUE — Electrical Data				MAXIMUM HEAT DISSIPATION for CONSTANT SLIP SERVICE Without special cooling
		6 Volt	12 Volt	24 Volt	100 Volt	
3½	0– 60 Lb. In.	1.4 amp.	0.65 amp.	0.34 amp.	0.12 amp.	0.15 HP
5	0–200 Lb. In.	2.0 amp.	2.5 amp.	1.2 amp.	0.25 amp.	0.30 HP
7	0–500 Lb. In.	4.6 amp.	2.5 amp.	1.9 amp.	0.26 amp.	0.45 HP

Angular Shaft Positions Accurately Indicated

An angular position encoder for general use, can be used for indicating instantaneously angular shaft positions of 360 deg or less with 0.1 percent accuracy without the use of gearing. A maximum shaft speed of 100 rpm is possible, and the unit can be connected directly to electro-mechanical printers or card punch equipment to give the decimal digital data.

The heart of the equipment is a new coded multi-segment commutator which transmits signals to a relay rack and gives data that can be recorded in decimal digital form either on a printed tape or a punched card. The commutator can be attached to self-balancing potentiometers to give digital data in the form of printed number tape from a printer or punch cards. The system includes three major components; the commutator which mounts on the rotating shaft; a relay panel; and a thyratron holding circuit,



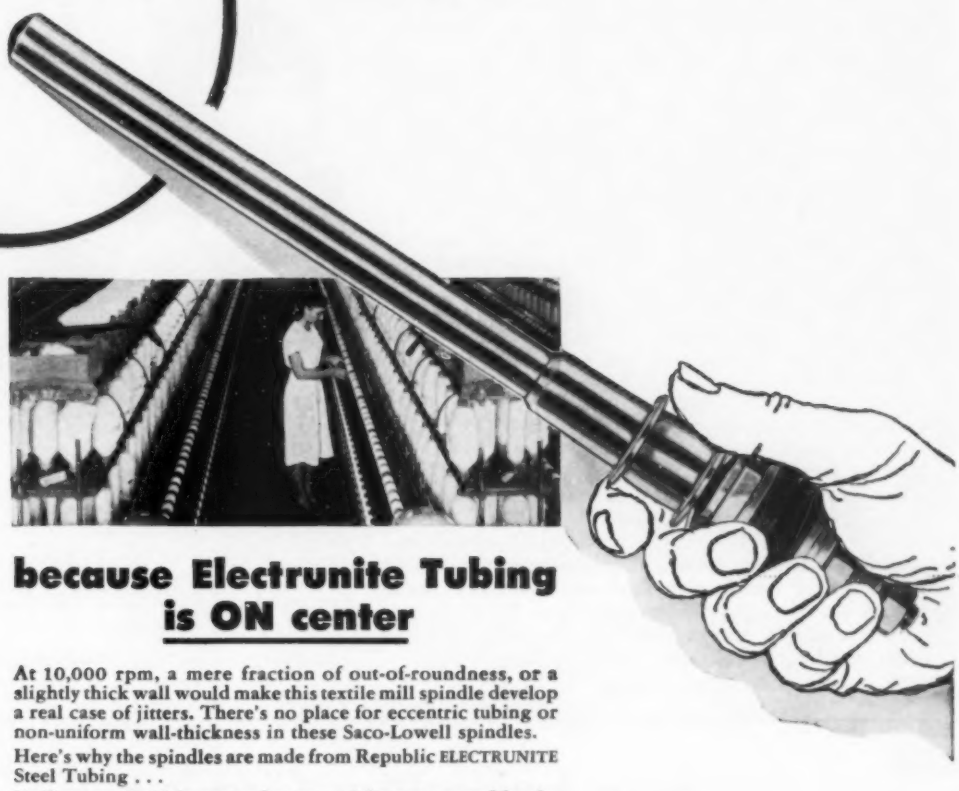
and will have application wherever a decimal representation of an instantaneous shaft position is required.

Also made by this company is a roto-stepper, a solenoid-operated stepping positioner with sufficient torque to drive many low torque mechanisms. It operates in 2 deg. increment, and rotates in both directions.

G. M. Giannini & Co., Inc.,
117 *E. Colorado St., Pasadena* 1, *Calif.*

CONTINUED ON PAGE 224

10,000 smooth RPM on 25% less power . . .



because Electrunite Tubing is ON center

At 10,000 rpm, a mere fraction of out-of-roundness, or a slightly thick wall would make this textile mill spindle develop a real case of jitters. There's no place for eccentric tubing or non-uniform wall-thickness in these Saco-Lowell spindles.

Here's why the spindles are made from Republic ELECTRUNITE Steel Tubing . . .

Uniform wall thickness and concentricity are assured by the way ELECTRUNITE Steel Tubing is made. The carefully rolled flat steel is inspected on both sides. Then it's formed on precision rolls into a cylindrical shape that's electric resistance welded to make a uniformly strong tube.

The tubes are uniform in every dimension, every contour. They can be fabricated uniformly to produce these spindles that must turn at 10,000 rpm.

One thing more . . . uniformity and concentricity contributed greatly to the development of ball-bearing spindles that cut textile mill power bills as much as 25%.

Probably you have products that would be better or cheaper or longer lasting if you made them from Republic ELECTRUNITE Steel Tubing. We'd like to help you investigate the possibilities.

STEEL AND TUBES DIVISION
REPUBLIC STEEL CORPORATION
222 East 131st Street • Cleveland 8, Ohio

Made By The Producers of
ELECTRUNITE—The Original Electric Welded Boiler Tube

REPUBLIC STEEL

Republic
ELECTRUNITE TUBING

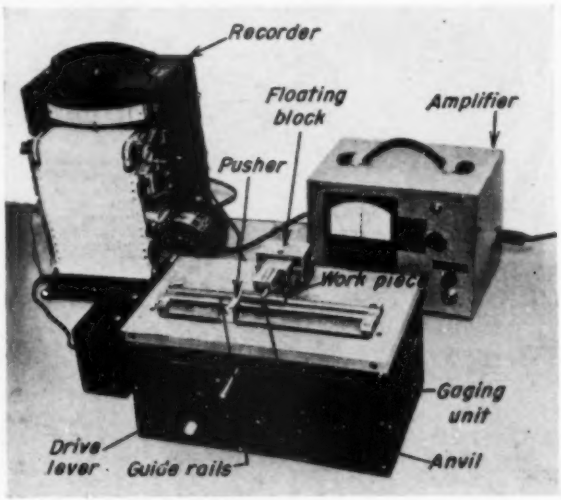
Deviation From Diameter Recorded In Millionths

For recording deviations from diameter along the full length of the work, this gaging equipment was developed for the inspection of cylindrical pins to ±0.000005 inch.

In operation, the work-piece is placed on a pair of cylindrical guide rails, using tweezers to prevent distortion due to body heat. The lever at the front is depressed, and a motor-driven pusher pushes the work to the right at constant speed, along the guide rails between an anvil and gage head. The recorder chart shows the deviation from nominal diameter in millionths of an inch along the full length of the work. The chart paper drive is synchronized with the movement of the work past the gage head; so the measurements can be read at any desired points along the length of the piece.

The measuring element consists of a Micro-Ac gage head made by this company, and an amplifier. The gage head is beneath the top plate, and has a special cylindrical contact tip at right angles to the axis of the work-piece. The tip contacts the under side of the work; and a corresponding cylindrical fixed anvil, parallel to the cylindrical tip, contacts the top of the work as shown. The gage head and anvil are mounted on a single rigid block, which is attached to the frame by reed-type springs so as to swing freely without friction or backlash.

The floating-block mounting of the gage head and anvil, plus the construction of the anvil and contact tip, prevents any error that would result from the work-piece moving slightly out of position as it moves along the guide rails. This also assures that the unit measures only the actual diameter of the work, regardless of the straightness.



A clamp knob at the front of the gaging unit sets the length of travel of the pusher to suit the length of work-piece. When the work is pushed beyond the gage head, the pusher automatically returns to starting position at fast travel and stops. With work-pieces of 2 in. in length, this equipment gages up to 120 pieces per hour.

Cleveland Instrument Co., 735 Carnegie Ave., Cleveland 15, Ohio

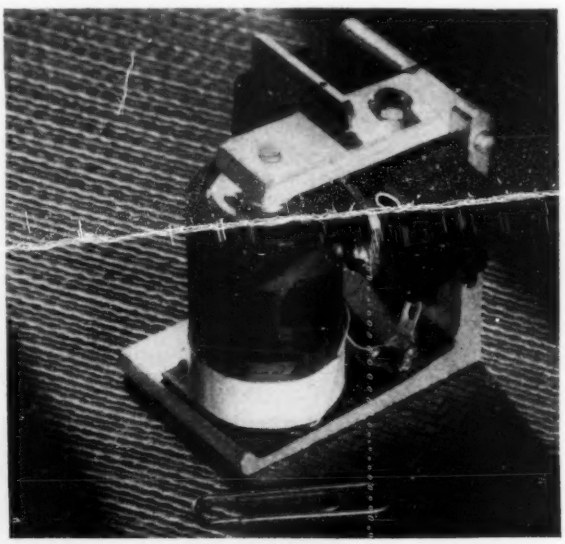
Snap-Action Plate-Circuit Relay

Positive, chatter-free circuit opening and closing under slowly increasing or decreasing currents are features of the new type C snap-action relay.

This relay uses a type BA2R snap-acting switch having characteristics suitable for inductive loads and those involving high inrush current. This construction is said to make the relay practically immune to shock, vibration, or tilting. Single-pole contacts, which can be wired for either normally-open or normally-closed conditions, are rated for 20 amp steady state currents and 75 amp inrush currents on voltages up to 460 volts a-c. On special units, other types of snap-acting switches with different contact characteristics can be supplied, as well as units in hermetically-sealed plug-in cases.

Other features: mechanical stability and a large cross-section magnetic path to make the relay relatively insensitive to variations in operating voltage; the frame is a section of annealed rolled-steel angle, into which the heavy movable leaf is hinged; the gap is adjustable by a screw and a locknut as well as by the position of a mechanical stop.

Operating characteristics can be varied from 8 to 12 ma pull-in and 2 to 6 ma dropout current to meet various functional requirements. It is designed to operate with a 2 mfd bypass capacitor, has a standard actuating coil of 3,000 ohms resistance, and is available in other resistances.



Thermo Instruments Co., 1137 El Camino Real, Belmont, Calif.

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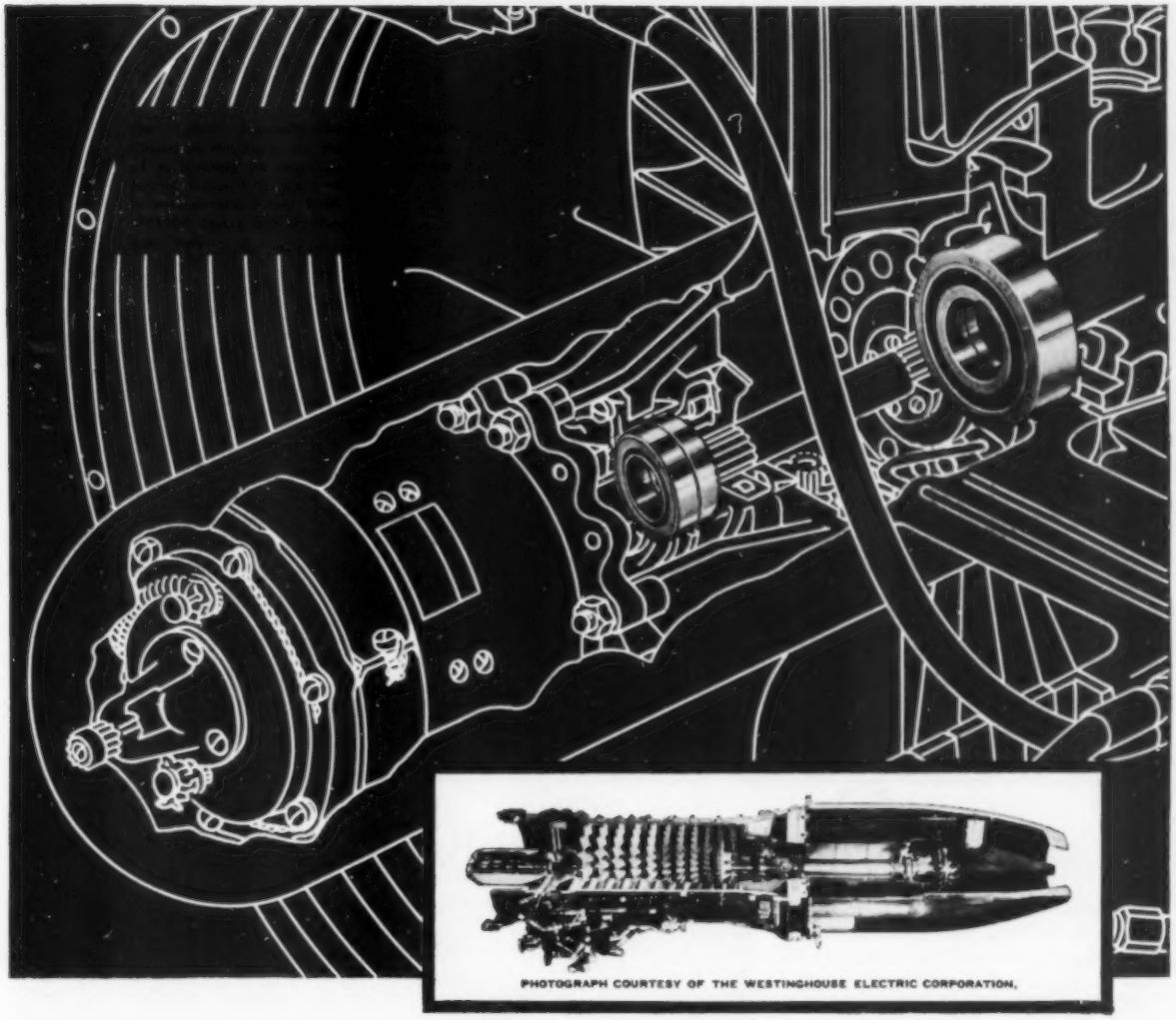
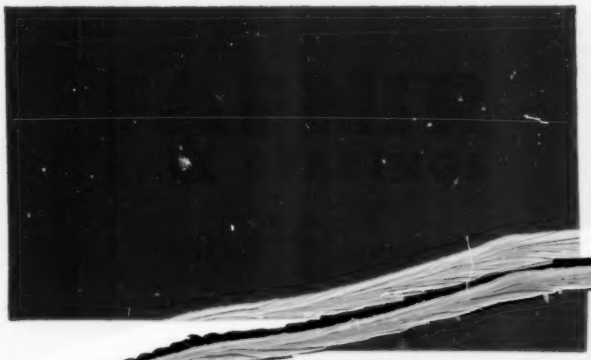


PHOTOGRAPH COURTESY OF THE WESTINGHOUSE ELECTRIC CORPORATION.

"SPIN FREEDOM" FOR TOMORROW'S JET ENGINES

Packing more power into less space . . . a trend in jet engine design . . . puts a premium on space-weight saving factors as well as performance. For "spin freedom" where every inch and every ounce counts, jet engine designers are turning to *Fafnir Super-Precision Ball Bearings.* In them, designers are getting "spin freedom" at a saving in weight and space . . . and they are getting proven performance too. These bearings, precision-built to millionths-of-an-inch tolerances, are now used at every important turning point on jet engines from main rotor to accessories and gear boxes.

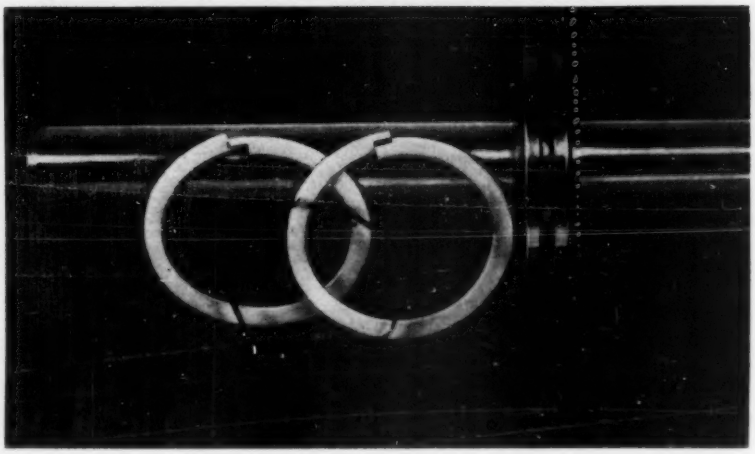
Through continuous research and collaboration with aircraft design engineers, Fafnir keeps in step with aircraft developments . . . and maintains leadership in the production of aircraft bearings. The experience gained, adds to Fafnir's general fund of knowledge that contributes so much to the Fafnir "attitude and aptitude" . . . a way of looking at bearing problems from the designer's viewpoint, an ability to supply the right bearing for the need. The Fafnir Bearing Company, New Britain, Conn.



High Pressure, Heavy Duty Dual Piston Seal

Made of Kelon-T, this dual piston ring seal for aircraft and industrial use, has an operating range from —100 F to +300 F, at pressures up to 5,000 psi.

Suitable for piston applications where very small amounts of leakage are allowable, the new seal is compact, compensates to bore irregularities, and has little shift during pressure reversal. Friction at all pressures is low, and the seal is inert, and has no corrosive action.

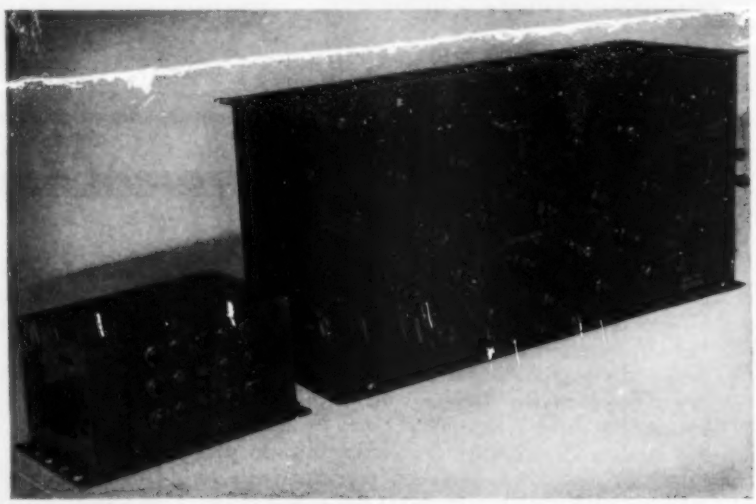


The BW series seal combines two identical Kelon piston rings with stepped, sliding joints, staggered to form a continuous seal, and a metallic expander ring. The joint arrangement allows for dimensional changes due to heat and pressure. Installed in the piston groove, the expander ring engages notches on the inside diameter of the seals, and prevents relative rotation of the seals and the consequent leakage were the joints to coincide. Radial force of the expander ring will give an effective seal at low pressure. Seals are available in sizes from 1 in. to 4 in. O. D. and are easily installed and removed.

W. S. Shamban & Co., 11617 W. Jefferson Blvd., Culver City, Calif.

Miniaturized Electrical Balance Panel

Constructed entirely of minaturized components, with a corresponding reduction in weight, the new model BP-2, 15 channel, miniature balance panel measures 6⅜ in. long by 3¾ in. wide by 3 3/16 in. high and weighs 1.5 pounds. A comparison is shown in the illustration of the new panel along with the BP-1 panel which used standard components.



The panel is designed specifically for use in flight test instrumentation and other applications where multiple channel data recording is required, and where the weight and size of the instrumentation equipment must be kept to a minimum. Applications of the model BP-2 include electrical balancing of circuits involving strain gages, accelerometer, position pick-ups, or any sensing devices that operate in electrical bridge circuits. The instrument has fifteen 25,000 ohm, 0.5 watt miniature ten-turn balancing potentiometers which have a linearity of ±0.5 percent. Precision, wire-wound, resistors used for calibration having an accuracy of ±0.1 percent are supplied with the panel. These resistors have a zero temperature drift over a range of —40 to +250 F. A miniature, ten-position, rotary switch is used with the calibrating resistors.

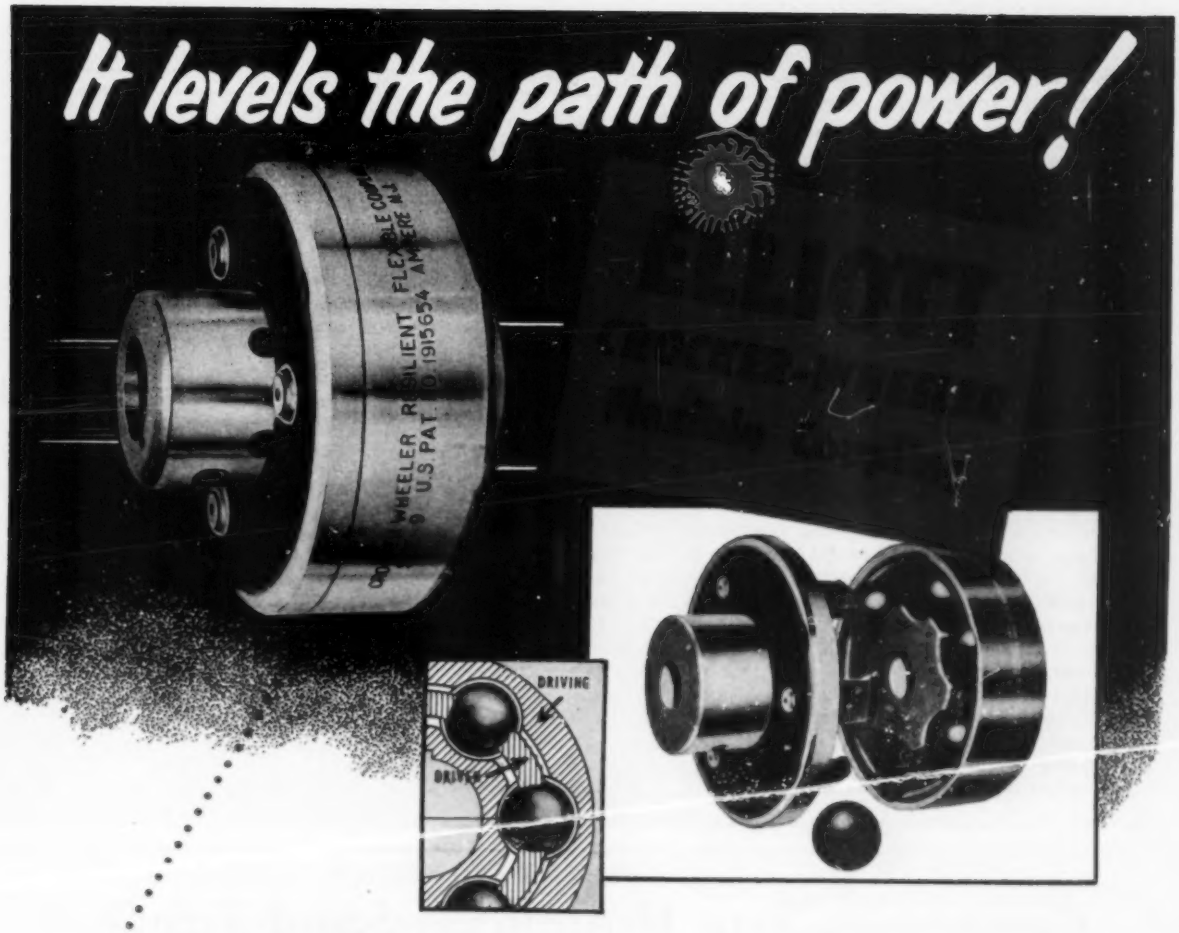
The panel is equipped with one output and two input plugs having 34 pins each. These plug contact pins are gold plated for positive, low resistance contact, and the plugs are polarized and self-aligning. Mating plugs with aluminum hoods are furnished with the panel.

A modified version has also been designed with provisions for both d-c and carrier powered bridge circuits.

American Helicopter Co., Inc., 1800 Rosecrans Ave., Manhattan Beach, Calif.

CONTINUED ON PAGE 228

It levels the path of power!



Six rubber balls are the connecting link between driving and driven unit. With the resiliency that only rubber can supply, they dampen the shocks of sudden starts and stops, and reduce or eliminate pulsation or other vibration-causing condition. They add life to the equipment they serve.

The rubber balls are tough, resilient, and long-lived. If or when necessary they can be quickly pushed out and replaced without dismantling the coupling or disturbing alignment.

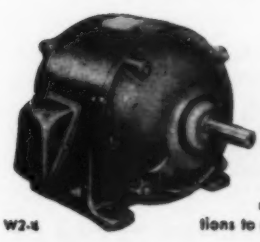
With this coupling you get not only great shock abosorbing capacity and positive drive without slippage, but also freedom from noise, vibration, and the need for lubrication or other maintenance. Full details in the C-W Coupling Bulletin at request. Address Elliott Company Dept. PE, Jeannette, Pa.

ELLIOTT Company

CROCKER-WHEELER DIVISION
AMPERE, N. J.

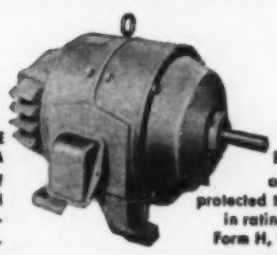
For large motors: RIDGWAY DIV., RIDGWAY, PA.
Plants at: JEANNETTE, PA. • RIDGWAY, PA. AMPERE, N. J. • SPRINGFIELD, O. • NEWARK, N. J.
DISTRICT OFFICES IN PRINCIPAL CITIES
ELLIOTT APPROVED SERVICE SHOPS COVER THE COUNTRY

A FITTING COMPLEMENT TO ELLIOTT C-W MOTORS



W2-4

SQUIRREL-CAGE PROTECTED FORM BA
Open dripproof motor for general use. Many modifications to meet special needs.



DC DRIPPROOF
and dripproof protected types Form F, in ratings to 7½ hp. Form H, 10 to 200 hp.

"SEALEDPOWER"
The famous C-W motor of ten-year reputation that cools and cleans itself with outside air blast. 3 to 125 hp. Also explosion-proof, 20 to 125 hp.

Seal-less, Leakproof, Centrifugal Pump

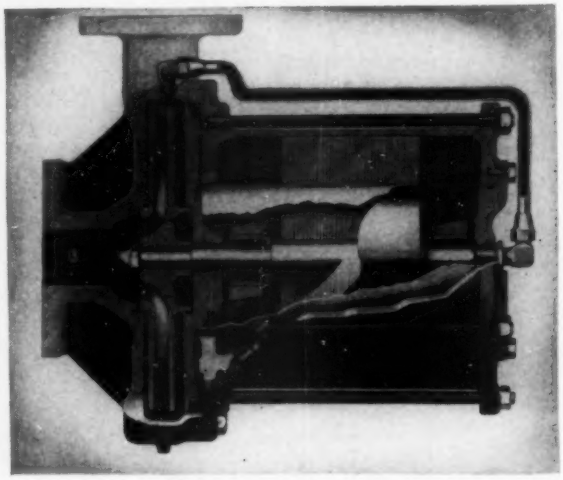
Having no stuffing box or packing to be adjusted, requiring no lubrication, and no shaft misalignment, the new Chempump has only one moving part and is totally enclosed. The moving part is the combined rotor and impeller, which can be removed without breaking the piping connections. And, as there is no seal, there is no way for corrosive, volatile, toxic, or radioactive fluids to leak out.

The fluid being pumped circulates through the rotor chamber of the motor, which is isolated from the stator. The fluid also circulates through the bearing assembly, giving constant lubrication. The bearings, the only wearing parts, can be replaced without removing the pump from the line.

The recirculation line, used when pumping clear fluids, circulates approximately 15-30 gal per hour of the fluid being pumped through the rear of the rotor chamber. This small amount of recirculated fluid limits the temperature rise.

The feature of the pump is the sealed motor. As fluid is permitted to enter part of the motor, the stator and its windings are isolated from the fluid by a corrosion resistant, non-magnetic alloy cylinder inserted in the air gap. The rotor is hermetically sealed with the same alloy.

Capacities: up to 150 gpm; working pressures: to 150 psi; temperature: up to 450 F. Integral models: 1, 2, and



3 hp; fractional models: $\frac{1}{3}$, $\frac{3}{4}$ hp. Motor, fully enclosed, for 3 phase, 50 or 60 cycle, 220, 440, or 550 v current. Standard pumps made of cast iron, stainless steel, and monel.

Chempump Corp., 1300 *E. Mermaid Lane, Philadelphia* 18, *Pa.*

Compression Type Hermetically Sealed Terminal

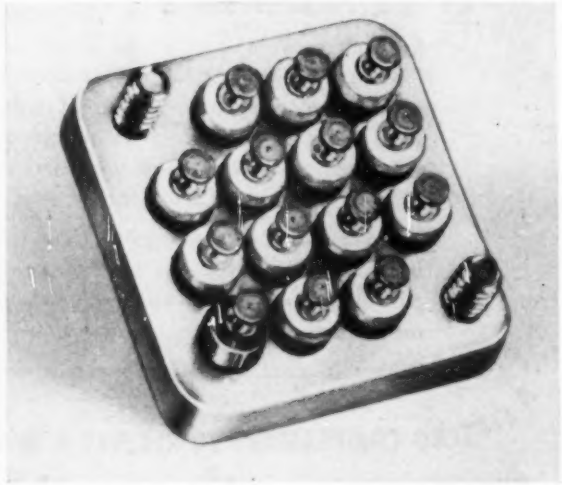
A new type of construction, a special sealing method, and a new assembly technique are features of this miniature compression-type, hermetically sealed terminal. Made in a range of terminal header styles, the unit is said to withstand severe vibration and shock without affecting the seal.

The unit consists of a tinned brass terminal stud, steatite insulators, and a silicone rubber seal. The silicone rubber is compressed between the steatite insulators and forms a seal by being displaced against an extruded hole in the cover plate and against the terminal electrode. The compression is held by an eyelet which is driven onto the end of the electrode and crimped. The eyelet serves as a lug for internal connection, and the entire assembly measures $\frac{7}{32}$ in. in dia by $\frac{5}{8}$ in. long.

The exposed silicone rubber seal is water repellent and serves to break the moisture path from the terminal stud to ground, which also greatly retards d-c plating. The temperature range of the terminal is —65 to +500 F. The rubber seal also absorbs vibration and shock without affecting the seal.

One of the applications for the new terminal is fo. mounting components on a terminal board and giving protection for the components when the assembly is subject to shock and vibration.

The most common application for the terminal is in terminal header assemblies. These can be furnished in combinations for all standard MIL-T-27 cases, as well as in special arrangements. The darker colored terminal is



used to identify the first terminal location. All metal parts have a hot tin dip finish for ease of soldering and for corrosion resistance.

For more information on this terminal unit and other types of electronic equipment, write to the manufacturer.

Torwico Electronics, Inc., 961 *Frelinghuysen Ave., Newark, N. J.*

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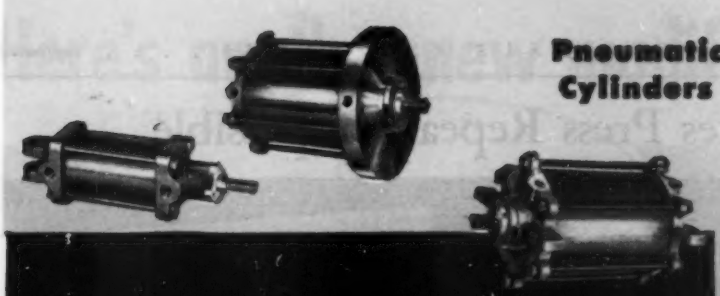


Pneumatic Cylinders

Really complete, the Hannifin line of pneumatic cylinders is made with two types of pistons . . . bores from 1″ to 16″ . . . six standard mountings. Really standard, these cylinders are tooled to tolerances that assure accurate mounting to make assembly to your machines easier. Really built, each cylinder is "TRU-BORED" and honed, piston rods are ground and polished, interchangeable end caps, heavy duty tie rods . . . rugged, yet precision construction throughout!

Write for Bulletin 210

NOW...

HANNIFIN HAS THE MOST COMPLETE LINE OF AIR CONTROL EQUIPMENT!

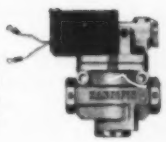
NEW! REVOLUTIONARY HANNIFIN *P-M Pilot-Master Valves*

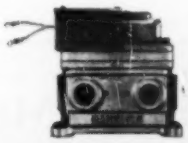
Piston-operated poppet design. Exclusive replaceable cartridge for easier maintenance. Speeds to 600 cycles per minute. Pressure from 15 to 150 p.s.i. Integral, solenoid-controlled pilot heads or a choice of 10 separate pilot valves for remote control.

- Fewer Valves to Stock
- Fewer Parts to Stock
- Maximum Interchangeability
- No Springs in Main Valve

Write for Bulletin 231.

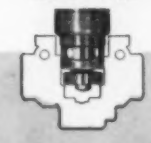
2 and 3-Way Valves.
Same valve operates 2-way or 3-way, normally open or normally closed. ⅜″ to 1¼″ I.P.S.



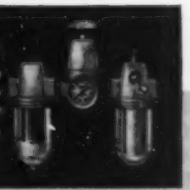


4-Way Valves.
Two 3-way valves mounted in compact, common body. Two piston poppets. Two cartridges. ⅜″, ½″, ¾″ I.P.S.

EXCLUSIVE REPLACEABLE CARTRIDGE



AIR WARDEN
Air filters, pressure regulators and lubricators to protect air operated equipment. Bulletin 1010B.



Disc Type Air Control Valves

Designed for smooth, positive and accurate control of air-operated equipment. Bronze discs lapped to perfect seal with seats. Packless design. For hand, foot or electrical operation. Sizes: ⅛″ to 1¼″ I.P.S.

Write for Bulletin 57-W

Hannifin "Directair" electrically controlled air-operated disc valve

Foot-operated treadle valve (Also spring return and rotary types)

Standard hand control valve (Single or duplex)

HANNIFIN

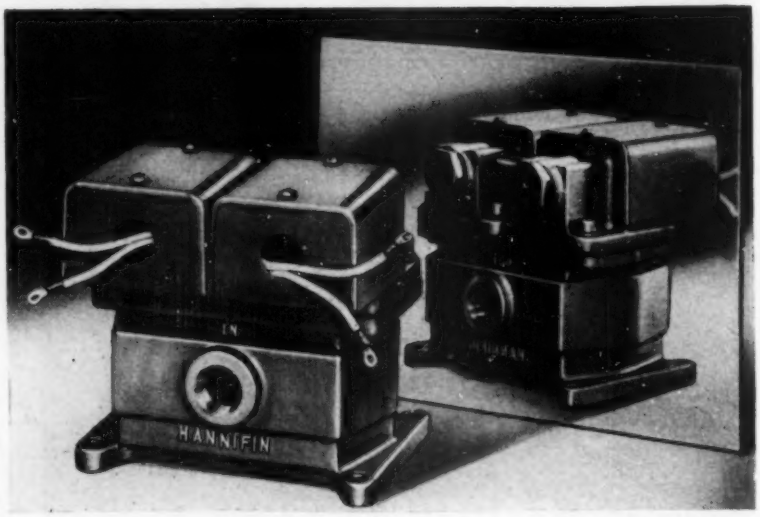
Hannifin Corporation, 1125 S. Kilbourn Ave., Chicago 24, Ill.

Air and Hydraulic Cylinders • Hydraulic Power Units • Pneumatic and Hydraulic Presses • Air Control Valves

Air Valve Makes Press Repeats Impossible

A special air control valve has been developed which is said to make practically impossible repeats due to valve failure on mechanical presses controlled by air-operated clutches and brakes. The new valve is a dual 3-way valve, which consists of two 3-way valves in parallel in one body. Both valves must operate to start the press, but if for any reason only one valve reverses, the unit fails safe and the press stops.

The new valve, called the P-M series BB-5, is offered only in ¾ in. IPS, and is capable of speeds in excess of 600 cycles per minute. It is similar to the B-3 valve, a single 3-way valve, also made by this company. It cannot fail other than safe, unless there is identical failure of both pilot sections or both main valves on the same stroke of the press.



The two solenoids in this dual valve are connected in parallel in the electric circuit of the press. The two pilot sections are interlocked pneumatically so that, if either solenoid fails to operate, the valve will not build up enough pilot pressure to operate either main valve and the press will not start. With the press moving, if either solenoid or either pilot valve reverses, pilot pressure will fall so low on both sides that both main valves will reverse and the press will stop. If one or the other of the main valves sticks in the "on" position, it will result in escaping air, as both exhaust ports carry away not only the incoming air through the "stuck" valve, but the air in the press clutch and brake mechanism, thereby stopping the press.

In normal operation, both main valves operate simultaneously, and reverse simultaneously. Their combined capacity, and the internal passages which connect the two valves, gives more than half again more air capacity than a single full-flow valve of the same ¾ in. IPS.

Each main valve consists of a removable cartridge which contains the piston-poppet assembly, the only moving part of the main valve. These piston-poppets are pressure actuated in both directions. Each pilot valve section has a pressure return type pilot stem, which opposes the action of the solenoid and results in positive reversal of the pilot valve when the solenoid is deenergized. The two solenoids are short-stroke, low-amperage, continuously rated, with transformer-type silicon iron plungers and frames. Hardened tool steel is welded across the entire plunger face to prevent spreading and jamming of the laminations. The solenoids can be completely disassembled, and coils for 115, 230, or 460 volts and for either 25 or 50/60 cycles are all available as standard.

Hannifin Corp., 1126 *So. Kilbourn Ave., Chicago* 24, *Ill.*

Pressure Relief Valve Has One Moving Part

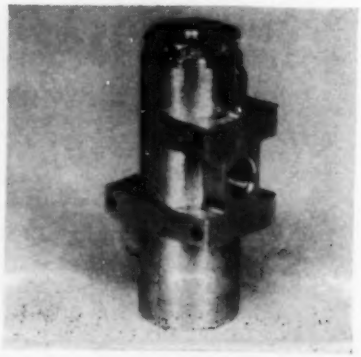
Advantages of a new pressure relief valve for both low and high pressures are that the device has only one moving part, is light in weight, and is easy to install because it requires little space.

Composed of less than a dozen parts, the valve will relieve and equalize excessive pressure of oil, water or chemicals to a pre-determined setting. Despite changes in demand it maintains pressures and it protects pumps by allowing flow through the pump.

The valve seat is formed of two hardened steel pieces which are ground and lapped for long life.

The relief valve is made in an in-line envelope with either normal or external adjustments and lock or in the side port envelope (right) with external adjustment and lock. Maximum free flow through valves is equivalent to the pipe size used.

The valve is produced in both aircraft and standard pipe sizes, being available in materials suitable to the application. Weight of the in-line type relief valve for ½ in. aircraft tubing is approximately 12 ounces.



Anco, Inc., 1 *Baker St., Providence* 5, *R. I.*

CONTINUED ON PAGE 232

Here's another new modified polystyrene

MC-305 is the easiest to mold of Koppers "high impact" series of Modified Polystyrenes. It has been used in such large area moldings as refrigerator door liners, air conditioning housings, and television masks and tube protectors.

MC-305's high resistance to shock and impact minimizes danger of damage to molded sections during ordinary production line handling as well as during actual use. Its shock resistant qualities also make MC-305 an excellent material for toys and novelties.

Possibly you have a product that can be made better or faster or less expensively with Koppers Modified Polystyrene. To help you choose the right Koppers material for your particular job, we have prepared a new technical bulletin detailing the properties of Koppers Modified Polystyrenes. Write today for your free copy.

KOPPERS POLYSTYRENES

Type 3	General Purpose Polystyrene
Type 7	Improved Heat Distortion Temperature
Type 8	Highest Heat Distortion Temperature
MC-185	High Impact, Lowest Water Absorption Rate
MC-301	High Impact, Improved Heat Distortion Temperature
MC-305	High Impact, Easy Flow
MC-309	High Impact, Highest Heat Distortion Temperature
MC-401	Medium Impact, Improved Heat Distortion Temperature
MC-405	Medium Impact, Easy Flow
MC-409	Medium Impact, Highest Heat Distortion Temperature

Koppers Plastics Make Many Products Better and Many Better Products Possible.

KOPPERS®

Koppers Plastics

Guaranteed by Good Housekeeping

KOPPERS COMPANY, INC., Chemical Division, Dept. PE-73, PITTSBURGH 19, PENNSYLVANIA

SALES OFFICES: NEW YORK · BOSTON · PHILADELPHIA · CHICAGO · DETROIT · LOS ANGELES

Fine Control With Air Operated Oil Dispenser

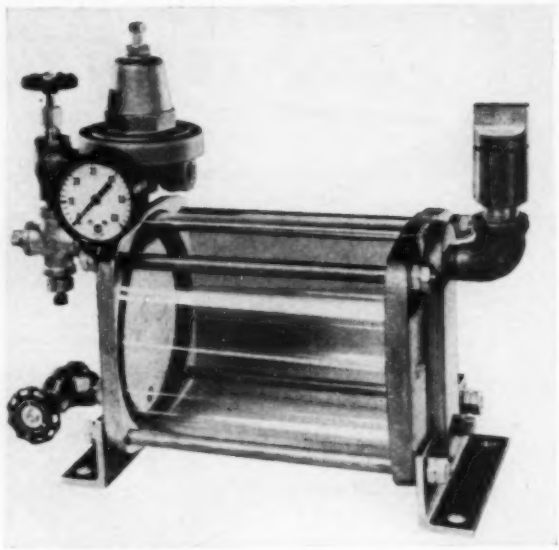
Oil and other fluids are fed by new air pressure operated dispensers to elevated, distant and inaccessible points for use on applications where gravity feeding is not suitable. The oil discharge can be controlled within wide limits by an adjustable air pressure, permitting use where conditions demand close regulation of oil flow.

These dispensers can be used on a variety of applications including spray oiling, and are designed to serve as central reservoirs of single line, low pressure air operated oiling systems, discharging a regulated amount of oil to individual bearings by means of adjustable sight feed needle valves.

In operation, air from a normal air line of 80 psi is connected to a pressure regulator on the dispenser, which allows any desirable reduced pressure setting. This lower air pressure is piped into the highest point of the reservoir and forces the oil through tubing to valves for dispensing to bearings.

Dispensers are furnished in sizes up to 2 gal in capacity for floor or wall mounting. The construction features the elimination of oil or air leaks. Aluminum endshields carry the transparent lucite reservoir between oil resistant gaskets. Four overbolts with lock nuts compress these rubber gaskets to give a positive seal. The oil supply is always visible through the transparent reservoir.

Air inlet as well as oil discharge can be manually turned on or off by shut-off valves. For automatic operation, a solenoid valve can be connected into the oil line. An air pressure gage with a range of 0-60 psi is supplied as standard equipment. Bases with mounting holes permit fastening of the unit to the floor or for wall mount[illegible]



Oil-Rite Corp., 2318 Waldo Blvd., Manitowoc, Wisc.

Electronic Liquid Level Control

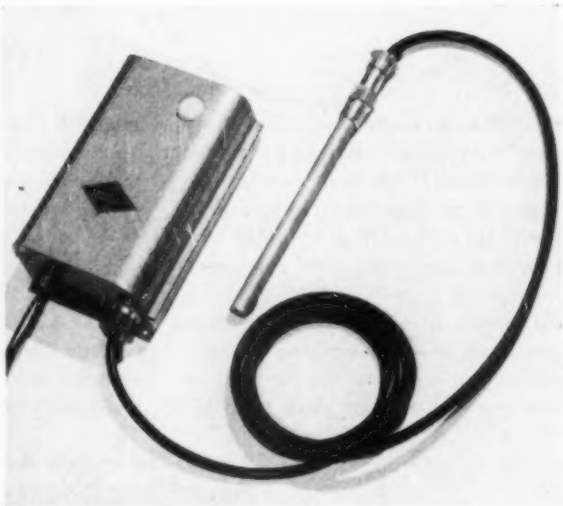
Based on the capacitive action of liquid surrounding a porcelain-enamel-covered-electrode, this new level control will adjust the level of a liquid and the cut-in, cut-out differential over very wide limits.

In operation, the new unit consists of the probe which is mounted directly at the location of the controlled liquid; a connecting cable which can be 1,000 feet long if necessary; and the control unit which can be located for operating convenience. The two main controls, liquid level and differential, are designed for screwdriver adjustment while a vernier, or fine control of the liquid level, is operated by a panel-front knob.

Standard models operate from 115 volt 60 cps supply while special units are available for 230 volt or 25 cps operation. The snap-action relay included in the unit is rated for 10 amp at 115 and 230 volts. An indicator light in the panel front indicates operation of the relay, burning at full brilliance when the relay is open, and at half brilliance when the relay is closed.

The differential range varies with the type of service but, for ammonia control the standard unit operates between approximately 1 in. and 5 inches. Wider ranges can be suplied with special units.

Among the applications are: low-side refrigerant-level control in refrigeration plants; liquid level, interface, proportioning and blending control in petroleum refineries; level control for production, packaging or production checking in chemical plants; and filler, measuring, mixing and operation controls in food processing plants.



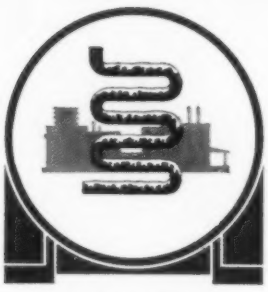
Thermo Instruments Co., 1166 El Camino Real, Belmont, Calif.

CONTINUED ON PAGE 234

Pumping

Ventilating

Metal Forming



Refrigeration

Oil Well Pumping

Electric Motors

for every industry

When you need electric motors . . . in any rating, or frame type . . . one or a thousand . . . *always* look for the Fairbanks-Morse Seal. For over 120 years it has stood for the finest in manufacturing integrity to *all* industry.

Fairbanks, Morse & Co., Chicago 5, Illinois.

Fairbanks-Morse QZK Motors—in a complete horsepower range.

FAIRBANKS-MORSE

a name worth remembering when you want the best

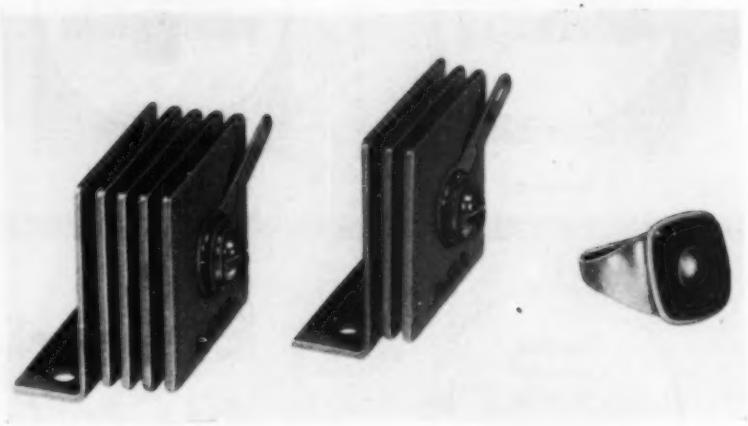
ELECTRIC MOTORS AND GENERATORS • DIESEL LOCOMOTIVES AND ENGINES • RAIL CARS • PUMPS • SCALES • HOME WATER SERVICE EQUIPMENT • FARM MACHINERY • MAGNETOS

Selenium Regulators For Low-Voltage Regulation

A series of selenium regulators, used for the regulation of relatively low d-c voltages, is recommended for the regulation of voltages in the order of 1.5 volts. This unit, known as the type D-568 regulator, consists of two specially processed selenium plates connected in series on a mounting bracket, and is the basic design of this series.

For operation, the selenium regulator is connected in shunt with the load and a voltage dropping resistor is connected in series with the source voltage and the load. Regulation is accomplished by utilizing the forward characteristic. The voltage across the voltage dropping resistor varies inversely with changing load current and the voltage is maintained.

Two other types of selenium regulators are available, type D-923 and type D-1064. These units are recommended for regulation of 2.0 volts and 3.0 volts d-c respectively. Regulators for higher voltages can be produced by adding more specially processed selenium plates to the basic design.



Hermetically sealed rectifiers, rated at 390 v rms input, are also available in metal cases filled with inert gas, and are provided with standard tube terminals to fit standard sockets.

International Rectifier Corp., 1521 *E. Grand Ave., El Segundo, Calif.*

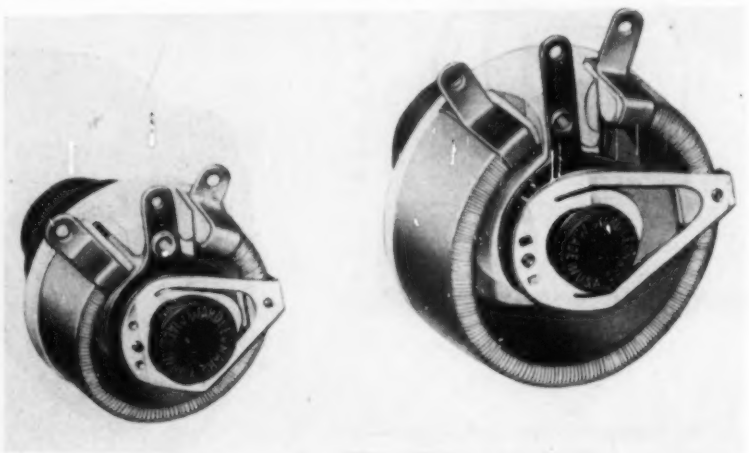
Close Current Control With Ring Type Rheostats

New 25 and 50 watt Vitrohm ring type rheostats with a contact arm and drive shaft assembly that furnishes smooth, close control with no backlash, have been designed for rheostat or potentiometer use in electronic and industrial control equipment.

A balanced spring steel contact arm that maintains uniform contact pressure is interlocked directly to an insulating hub molded to the drive shaft. This construction gives direct drive operation between control knob and contact shoes. Smooth control is further obtained by using two metal graphite self-lubricating contact shoes. The standard rotational travel is 280 deg. for 25 watt rheostats, and 300 deg. for the 50 watt size.

Known as the bulletin 1110 rheostats, both the core and base are molded of high density, low porosity and high dielectric strength ceramic. High stability resistance wire, wound toroidally on the core, is held secure by the vitreous enamel.

Watt ratings are based on a 300 C rise in 40 C ambient. Resistance values for the 50 watt size range from 1 to 7,500 ohms, with the number of steps ranging from 49 to 855. Standard resistance tolerance is +20, —10 percent.



The rheostats are said to have particular use in a-c or d-c circuits where a stepped rheostat does not give sufficiently close adjustment. Typical applications include control of fractional hp motors, filament and battery circuits, rectifiers, voltage regulators and similar electronic equipment.

These rheostats can be supplied with tapered windings, slotted shafts for screw driver adjustment, toggle switch, and with locking devices to prevent changes in resistance setting.

Ward Leonard Electric Co., 31 *South St., Mount Vernon, N. Y.*

CONTINUED ON PAGE 236

full strength

ON

Republic Upson "Nylok*" Nuts

12 WAYS BETTER

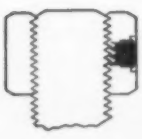
- Assemble from either end
- Can be re-used
- Non-galling
- Best wrenching characteristics
- Won't damage threads
- No special know-how
- No special tools
- One piece
- Ideal for mechanical feeding
- No lubricant needed
- Cold-forged
- Lock in any position

Every thread on a Republic Upson "Nylok" Nut is at work, helping hold the nut tight, even against severe vibration. The nine-lived nylon plug in the side forces the opposite side of the nut tightly against the bolt the *whole thickness* of the nut.

Republic Upson "Nylok" Nuts are easy to apply . . . . simply screw them on . . . . either way is "up". They are easy to unscrew when you want them off. And they're ready to *re*-use.

Samples will be sent on request . . . tell us the sizes you are interested in.

Light series tapped ¼" thru ¾"
Light thick series tapped ¼" thru ½"
Regular sizes tapped ¼" thru ½"
Heavy series tapped ¼" thru ½"



Here's how the "Nylok" principle works

A nylon plug inserted in one of the sides of the cold-forged nut forces the nut tightly against the opposite threads as the nut is turned on.

*U. S. Patent Numbers 2,462,603 and 2,450,694 and pending application

REPUBLIC STEEL CORPORATION
Bolt and Nut Division • CLEVELAND 13, OHIO
Export Department: Chrysler Building, New York 17, N.Y.

Republic
REPUBLIC STEEL
BOLTS AND NUTS

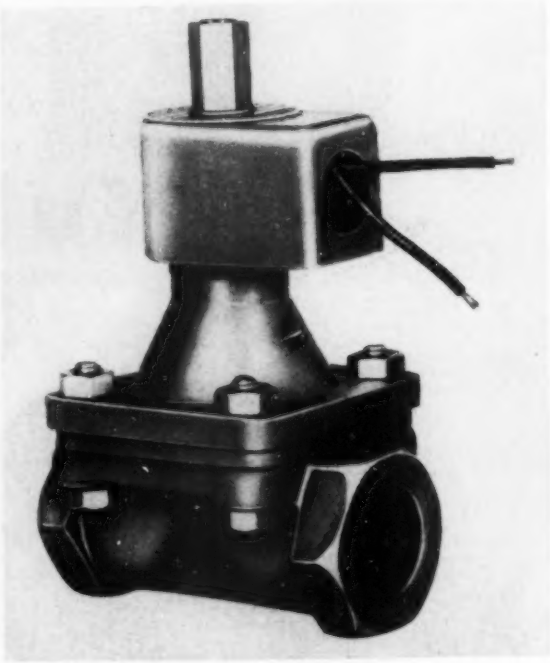
Pilot Operated Valve Handles Corrosive Materials

Used in the handling of corrosive liquids and gases, and food products, particularly those containing solid particles, a new pilot-operated valve features a design that has a completely tight shut-off. Known as the model 8336 valve, it has only two moving operating parts: the flexible diaphragm and the solenoid core. Pressure, air or liquid, is introduced directly from the pilot and impressed upon the diaphragm to close the valve. When this pressure is released, the line pressure opens the valve.

Pipe sizes range from ½ to 2 inches. Standard voltages are 115-230 a-c, 50-60 cycles and 115 d-c. Maximum temperature is 180 F. Special enclosures available include: NEMA type IV watertight, and NEMA type VII class 1 group D explosion-proof. A class H high temperature coil is available for 115 or 230 volts, 50-60 cycles only. Valve bodies are cast iron, bronze or stainless steel.

Maximum height from top of solenoid to bottom of body in the screwed and construction ranges from $6\frac{5}{16}$ in. for the ½ in. size to $8\frac{5}{8}$ in. for the 2 in. size. For flanged end construction, heights for corresponding sizes are $7\frac{3}{8}$ in. and $10\frac{1}{16}$ in. respectively.

The standard pilot valve may be used for pressures up to 125 psi. The class H high temperature coil permits pressures up to 150 psi. Separate source pressure must always exceed line pressure, the excess varying with size and type of diaphragm.



Automatic Switch Co., 391 *Lakeside Ave., Orange, N. J.*

Electronic Wattmeter Has High Accuracy

Basically an amplifier driving the potential coil of a dynamometer, a new electronic wattmeter features a range from 0.3 to 300 watts on six scales, with accessory shunts extending the range to 9,000 watts. With the amplifier driving the potential coil of a dynamometer wattmeter, a 500,000 ohm input impedance is provided to the potential circuit; a sensitivity to low potentials; and operation from 20 to 3,000 cps.

The high input impedance to the potential circuit eliminates errors associated with potential coil current, such as voltage drops in the ballasts when measuring power input to fluorescent lamps. The sensitivity permits measurements of low-voltage circuits, such as the power supplied to fuses, to small motors, and to transformers for core loss testing. With the wide frequency response it is possible to measure linear and non-linear circuits at all power frequencies and their harmonics, without correcting for nonsinusoidal waveform.

The wattmeter ranges are 1.0, 3.0, 10, 30, 100 and 300 watts full scale. A maximum voltage limit is indicated for each wattage range to prevent amplifier overloading and insulation breakdown. Limits vary from 300 volts rms (sinusoidal waveform) on the 300 and 100 watt ranges to 3.0 volts rms on the 1.0 watt range. Corresponding limits for non-sinusoidal voltages are from 420 v to 4.2 v zero-to-peak. The maximum voltage limits are high enough to permit full-scale reading with a 30 percent power factor and 1.0 amp load.

The maximum permissible current is 1.0 amp, but external shunts will permit measurements to 30 amperes. With maximum allowable voltage and unity power factor, 300 milliamps in the current coil will give a full-scale reading.

Keithley Instruments, 3868 *Carnegie Ave., Cleveland* 15, *Ohio*

CONTINUED ON PAGE 238

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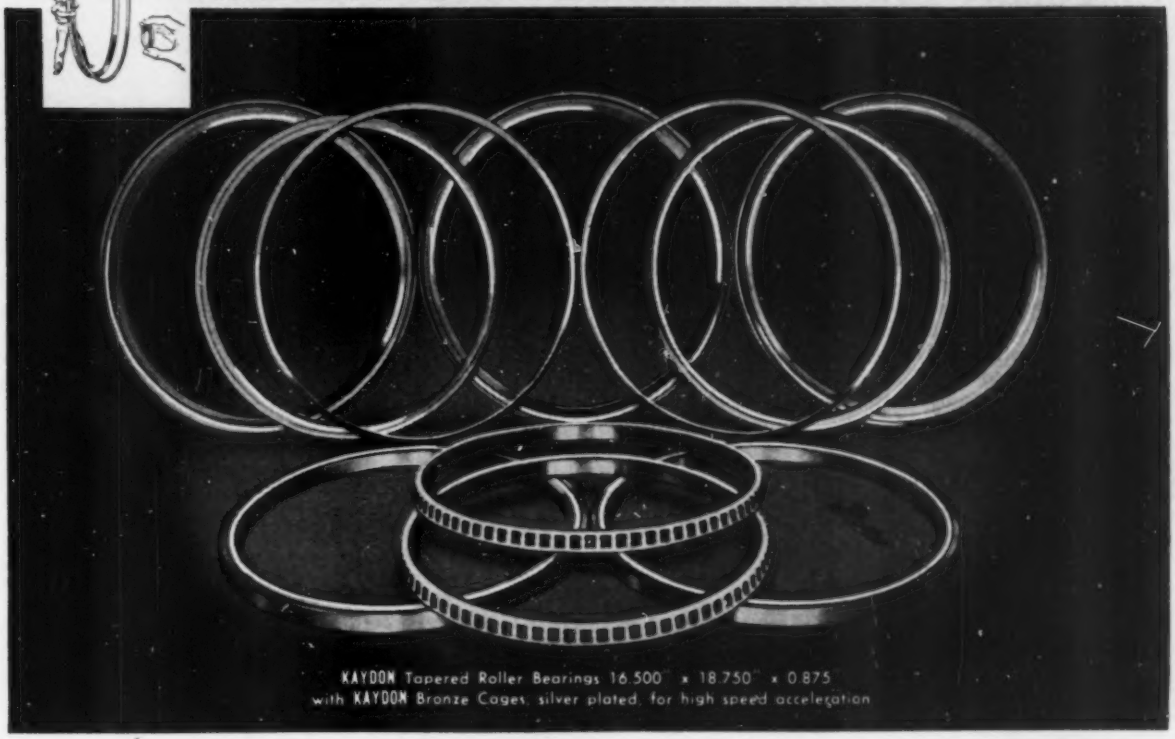
Contact KAYDON Muskegon

FOR ALL TYPES OF BALL AND ROLLER BEARINGS: 4" BORE TO 120" OUTSIDE DIAMETER



KAYDON Tapered Roller Bearings 16.500" x 18.750" x 0.875"
with KAYDON Bronze Cages, silver plated, for high speed acceleration

Safe Way to Reduce Weight

Look again at this thin section bearing. KAYDON bearings like these, designed with very thin section, are a boon to design engineers who recognize weight-reduction and greater precision as prime problems today.

KAYDON Thin-Section Tapered Roller, Straight Roller, and Ball Bearings are helping solve such problems. All types can be made unusually light in weight, and permit much more compact machine design.

Unique high precision techniques that hold to closest tolerances in bearings as large as 120 inches outside diameter, assure consistent accuracy in all types and sizes of KAYDON bearings and needle rollers.

★ ★ ★

For your precision bearing requirements, contact KAYDON of Muskegon.

We specialize in large, thin-section, light weight precision bearings
for Aircraft, Automotive, Military and Industrial Equipment

KAYDON Types of Standard and Special Bearings:
Spherical Roller • Taper Roller • Ball Radial • Ball Thrust
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THE KAYDON ENGINEERING CORP.

MUSKEGON • MICHIGAN

PRECISION BALL AND ROLLER BEARINGS

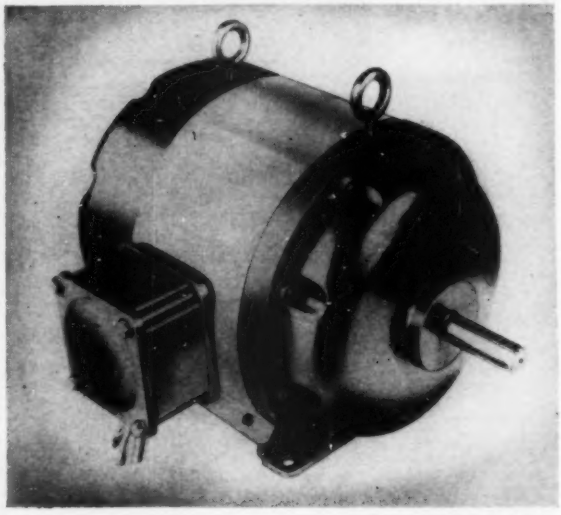
Totally Enclosed Motors For Chemical Applications

In ratings of from one to 40 horsepower, and in NEMA frames up to 405, a new line of chemical plant motors will be available in totally-enclosed and explosion-proof construction. Special class A chemical insulation treatments will permit the use of the new motors in applications involving acids, alkalis, dying and bleaching, canning and packing, and peroxide.

A variety of construction modifications is available, including a choice of cast bronze, cast aluminum, or cast iron ventilating fans. Cast bronze, cast iron, stainless steel, or flattened expanded metal ventilating grilles may be used and automatic drain-and-breather plugs, as well as stainless steel shafts, can be supplied if necessary. All frames are constructed with stainless steel outer shells.

In addition to the special treatment for chemical applications, protection of the metal parts against corrosion is also included. Steel parts are dipped in a special corrosion-resisting coating, and are then baked and painted. The die-cast rotor is sprayed with a special corrosion inhibitor, and the cast iron end heads and terminal box are cleaned and treated with a combination zinc chromate and iron oxide primer.

The terminal box on totally-enclosed models is gasketed and power leads are sealed at the shells with a non-hardening compound. Repellent grease at the shaft extension hub keeps moisture away from the bearings. These bearings, prelubricated and sealed on both sides, are double-row width, and a sealed-in grease permits maintenance-free operation for five years or more.



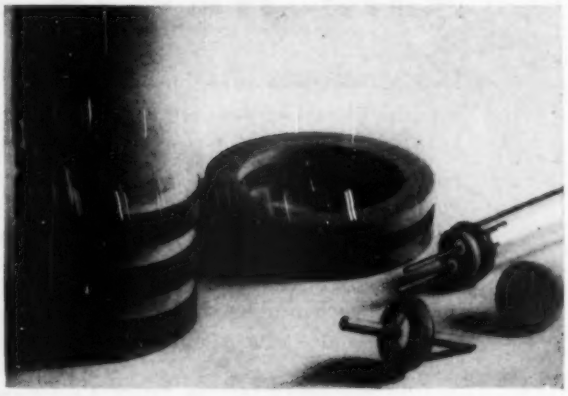
Robbins & Myers, Inc., Springfield 99, Ohio

Metal-Ceramic Seal Withstands High Temperatures

Seals produced by a new process for metallizing ceramic materials, for attached metal parts are said to withstand operating temperatures of 1,200 F, surpass JAN thermal shock requirements, and maintain a vacuum-tight seal under a wide range of temperature and pressume combinations.

These characteristics are obtained by combining a group of ceramic materials with new design principles, and the controlled metallizing process known as AV55. In many applications, non-magnetic conductors can be used, resulting in lower loss factors at high frequencies than other sealing methods. Plating upon the metallized surface will not peel or blister.

Applications include: electronic and electrical devices, ignition systems, plumbing, and a variety of components needed for aircraft, missiles, chemical, and heating appartus.



Advanced Vacuum Products, Inc., P. O. Box 197, Southport, Conn.

AN AUTOMATIC, air and hydraulically actuated test stand for determining the physical characteristics of any seamed tubing up to 3 in. in dia is capable of testing specimens of steel, stainless steel and carbon steel tubing for flaring, column and crushing strength, with pressures up to 100,000 pounds. The test stand is self-contained, has a hinged safety guard, and requires a connection to 60-80 lb. air supply. Operation of the unit is by solenoid, push-button control after the test specimen is inserted between fitting anvils. The Dommers Co., 428 South Cherry St., Wallingford, Conn.

SMALL, LONG-LIFE ACCELEROMETERS, hermetically sealed in an inert gas, come in resistance ranges from 1,000 to 20,000 ohms and for accelerometer measurement up to 30 G. Potentiometer element carries current up to 10 milliamperes. G. M. Giannini & Co., 117 E. Colorado St., Pasadena 1, Calif.

CONTINUED ON PAGE 240

BARCO JOINTS

for

BANBURY MIXERS

produced by

FARREL-BIRMINGHAM

Photo: Size B Banbury Mixer.

① SWIVEL JOINTS

New lower torque Barco Swivel Joints enable you to put flexibility where you want it—without the nuisance of sagging, flopping, non-rigid lines. Easy to position lines for good drainage on steam applications—no water pockets, better temperature control! Exclusive design provides 360° swivel action plus *side flexibility* to prevent binding. No leakage under varying conditions of vacuum or pressure, heat or cold. Ask for engineering recommendations and latest literature.

② REVOLVING JOINTS

Here is Barco's new, *improved* Type IBR Revolving Joint for supplying steam, water, oil, or other fluids to rolls, dryers, drums. Inherent *low torque* is little affected by pressure, speed or temperature—thanks to special ball bearings used in combination with self-lubricating graphite-carbon bearing. Internal parts are readily accessible—usually without removing joint. Single flow or syphon styles. Ask for Bulletin 300.

Among fabricators of rubber, plastics, linoleum, asphalt products, and other heavy compounds, Banbury Mixers are recognized as one of the most efficient types of production equipment ever developed. Designed and manufactured by Farrel-Birmingham Company, Inc., Ansonia, Conn., Banbury Mixers embody many advanced engineering features. Here, as elsewhere, you will find BARCO: (1) Barco Swivel Joints to provide *flexibility* in piping and (2) Barco Syphon Style Revolving Joints to provide *rotating* connections for steam or cooling water piping to mixer rotors.

If you have a design or operating problem that calls for flexibility, movement, or rotation in piping connection, BARCO HAS THE ANSWER!

BARCO *Manufacturing Co.*

527H Hough St., Barrington, Illinois (A Chicago Suburb) • *In Canada:* The Holden Co., Ltd.

FREE ENTERPRISE—THE CORNERSTONE OF AMERICAN PROSPERITY

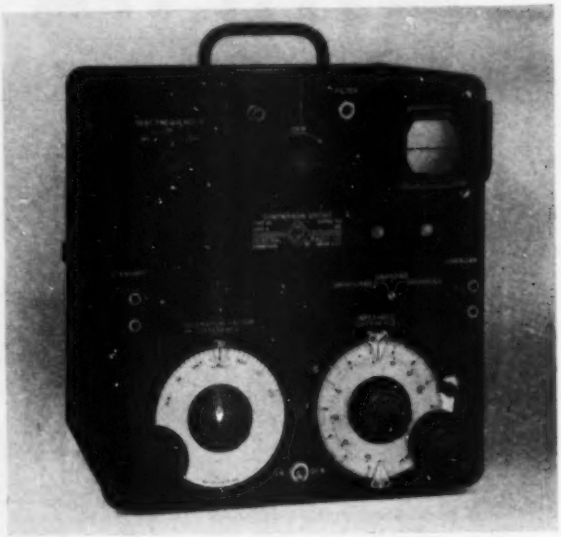
Direct Comparison of Electronic Components

Accurate and simple production tests are possible on the new general-purpose type 1604-A Comparison Bridge. With a basic accuracy of 0.1 percent, the bridge can be used for direct comparison of resistors, capacitors and inductors over the wide impedance range of about 2 ohms to 20 megohms. Two impedance-deviation ranges of ±5 percent and ±20 percent are included.

Dissipation-factor (or storage-factor) differences are also indicated. The bridge is completely self-contained with a cathode-ray visual detector and an oscillator operating at either 1 kc or 5 kc. Operation is from the a-c line. The point at which the bridge is grounded can be switched, so that measurements can be made with the unknown either grounded or ungrounded.

The primary application for the comparison bridge is that of sorting components to a given tolerance. The standard to be used does not have to be a precision standard, but can be a component which has been independently measured.

The bridge may also be used for measuring center-tapped windings to be sure that the tap is correctly centered; for checking ganged potentiometers and capacitors; and for measuring small capacitors of a few micromicrofarads by placing them in parallel with, 100 micromicrofarads.



General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.

Miniature Blowers For Electronic Equipment

Miniature blowers, developed primarily for cooling industrial and airborne electronic equipment, consist of a scroll which directs the flow of air produced by the enclosed blower wheel, and a suitable back plate. They are available in 4 sizes: 1½, 2, 2½, 3 in., with the numbers indicating the diameter of the blower wheel.

Molded from a new Alkyd plastic material which is reinforced with fibre glass, the scrolls have high-impact strength and good dimensional stability. This high strength makes possible thinner wall, shells, reducing overall weight, and reduces breakage from handling and assembly.

The material also has a low water absorption rate, good electrical properties and will not support combustion. The manufacturer claims that the scrolls will withstand instant temperature changes from —55 C to +125 C, without crazing or being damaged.

The blower wheels are the Sirocco type, aluminum or cadmium-plated, with wheel hubs which can be furnished in any standard bore. The blowers are driven by miniature 400 cycle or variable frequency electric motors.

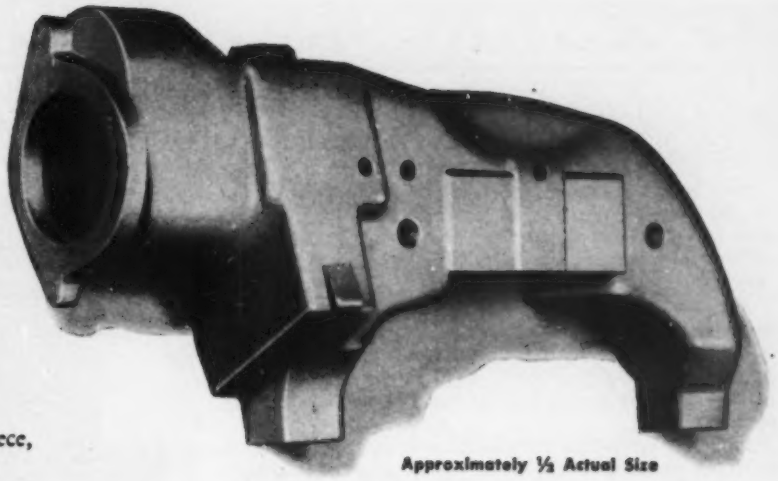
Electroflow Pumps, Inc., 4811 Anaheim-Telegraph Rd., Los Angeles 22, Calif.

A MINIATURE TEMPERATURE CONTROL DEVICE with an inherent sensitivity of less than 1F may be set at any temperature in the range from zero to 200F by turning an adjusting screw. Available in rectangular and cylindrical models, measuring ¾ x ⅜ x 1 1/32 in., and ¾ in. dia and 1 1/32 in. thick respectively, both are rated at 2.5 amp at 115 v a-c or 2 amp at 28 v d-c. Various types of mountings are available. Fenwal, Inc., Ashland, Mass.

MADE OF POLYETHYLENE, 1 and 2 in. valves are light in weight (the 2 in. valve weighs less than 6 lb) and resist hydrofluoric, sulfuric and other acids at temp. up to 160 F. American Agile Corp., Box 168, Bedford, Ohio.

CONTINUED ON PAGE 242

A Master Design Formula

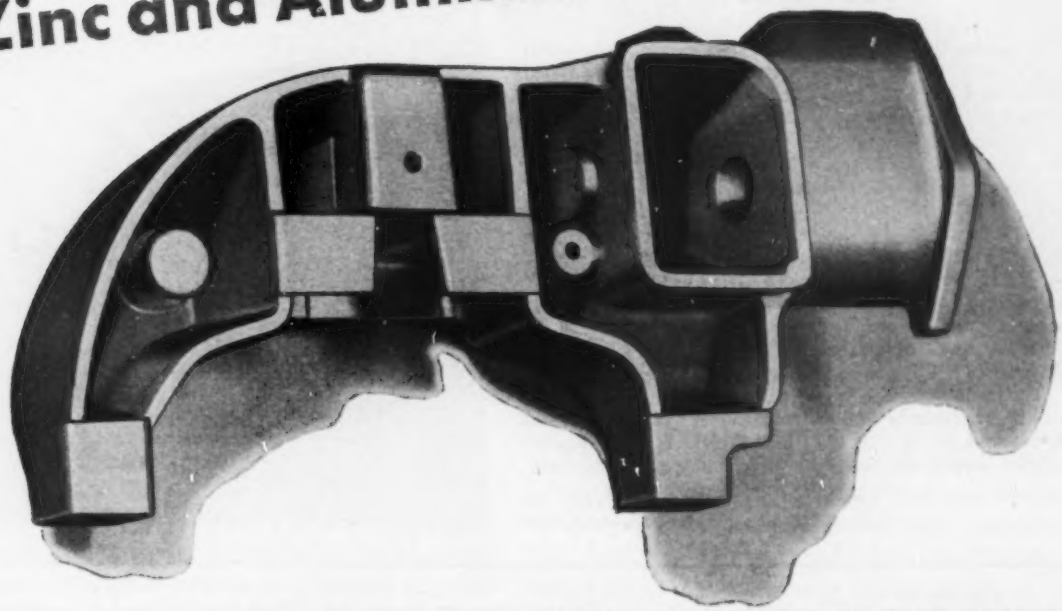


Approximately ½ Actual Size

Consolidate functions in one piece, combine light metal lines with high strength and provide pleasing appearance with high production potentials — with Madison-Kipp Zinc and Aluminum Die Castings

MADISON - KIPP

Zinc and Aluminum Die Castings



kipp

Designers are becoming more and more conscious of the advantages of the high pressure die casting process. They can believe established facts as illustrated here. They can duplicate these favorable economic results in their own designing. Madison-Kipp is skilled and seasoned in die casting mechanics and invites your inquiries for co-operative effort.

MADISON-KIPP CORPORATION

206 WAUBESA STREET • MADISON 10, WISCONSIN

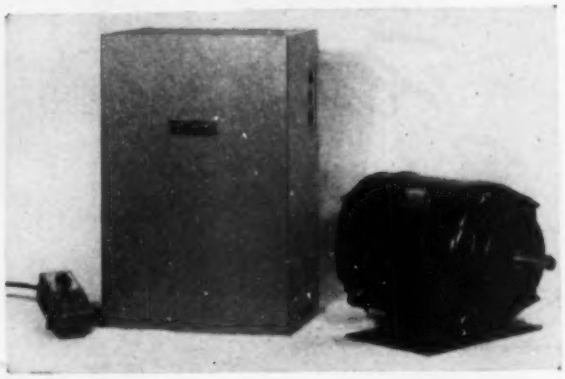
• Skilled in Die Casting Mechanics • Experienced in Lubrication Engineering • Originators of Really High Speed Air Tools

Variable Speed Motor Control Systems

A redesigned line of electronic variable speed motor control systems, up to and including 3 horsepower models, now have special terminal block transformer construction, and special cabinet design for wall or bench mounting and critical component plug-in assemblies.

The motor series field is utilized as a torque signal source in a patented feedback circuit to give constant system torque capability. Controlled acceleration on many models permits use in applications of high inertia loads without placing excessive torque load on materials in critical processes.

Fingertip controlled models for manual speed selection at remote points are available, as well as a line of automatic servospeed systems for use in various operations or processes. Automatic tension control, constant surface speed wind-up and other automatic models are available, as well as memory type systems operating from tape recorders to follow previously determined time speed sequences.



Electro-Devices, Inc., 6 Godwin Ave., Paterson, N. J.

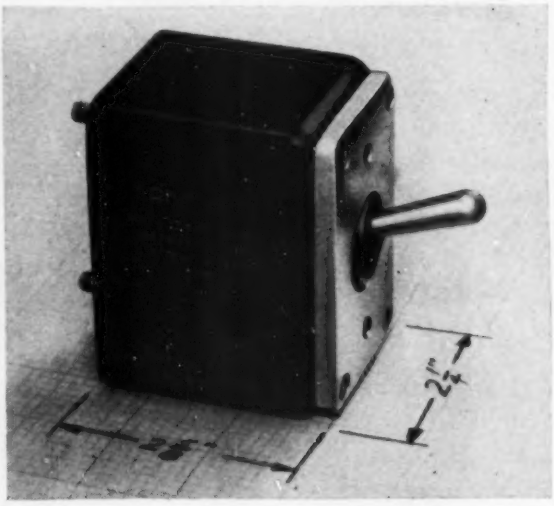
Heavy Duty Waterproof Toggle Switch

In addition to being waterproof, a new heavy-duty toggle switch is dust-tight, quickly and easily installed, functions from —65 to +165 F and withstands shock, vibration and salt spray.

The switch mechanism is encased in a rubber compound which acts as a waterproof seal around the toggle and between the mounting plate and the switch itself. Continuous rating of the switch is 175 amp at 15 or 30 volts d-c or 125 volts a-c. Maximum inrush capacity on any type of load is 500 amperes. Toggle and pole arrangement is for SPST. In one application, the switch is "ganged" in pairs to handle 300 amperes. This is accomplished by using a gang bar attached to both toggles, which actuates them as a single toggle, and through the use of a connecting device between the poles to make them a common pole.

The switch can also be wired in multiple as DPST, and will be available in a SPDT arrangement as well. Overall dimensions are $2\frac{1}{4}$ x $2\frac{5}{8}$ x $3\frac{1}{2}$ in., with the toggle extending $1\frac{7}{16}$ in. beyond the mounting plate at the top of its travel.

Riverside Mfg. & Electrical Supply Co., 10228 Michigan Ave., Dearborn, Mich.



HYDRAULIC CYLINDERS for working pressures up to 2,000 psi, with 3,000 psi for non-shock service, feature all-steel bodies, bored barrels, hardened piston rods, rod scrapers, and new cartridge type packings, with cushions optional. Known as the series J cylinders, they are available for oil or water service in bore sizes up to 10 in. in diameter. The new line is available with standard foot, flange, pin-eye, and trunnion mountings. Hydro-Line Mfg. Co., 19th St., Rockford, Ill.

A MIDGET CENTRIFUGAL PUMP for handling liquids where capacity requirements range from 0 to 6 gal per min from free flow to 6 ft of head, measures 5 in. in dia, 9 in. overall, and weighs about 5 pounds. Adaptable to such applications as: laboratory work, commercial advertising displays, and water cooling units, the pump is designed for intermittent operation, and can be supplied in brass steel, and Monel metal. Pioneer Pump Div., 19657 John R. St., Detroit 3, Mich.

DESIGNED to measure radiant-energy intensities up to 10 watts per sq in., a new infrared meter will determine almost instantaneously the intensity of high range, radiant-energy sources, and can be used for studies of infrared radiation effects concerning absorption and transmission properties of materials. Accuracy is ±5 percent of full scale value over a response range of 300-3,500 millimicrons (3,000-35,000 angstroms). General Electric Co., Schenectady 5, N. Y.

CONTINUED ON PAGE 244

KOHLER

PRECISION CONTROLS

KOHLER PLUG VALVES

Aircraft Industrial Automotive

Drain cock for a helicopter fuel system, hydraulic control valve for machine tool operation, shut-off valve for instrument air line or control plug valve for industrial test stand—whatever your need, you can, to your advantage, use Kohler Plug Valves. They will meet all your lower pressure installation and operating specifications.

Kohler Plug Valves have a stainless steel plug, precision lapped into a forged aluminum body—and are furnished with two, three or four ports, with or without mounting flanges, and with two or three way drilled plugs.

Write us regarding your next precision control requirements. We'll send information to help solve your design or production problem.

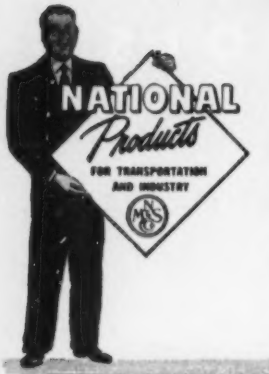
Kohler Co., Kohler, Wisconsin. Established 1873

KOHLER OF KOHLER

PLUMBING FIXTURES • HEATING EQUIPMENT • ELECTRIC PLANTS • AIR-COOLED ENGINES • PRECISION CONTROLS

Castings by National

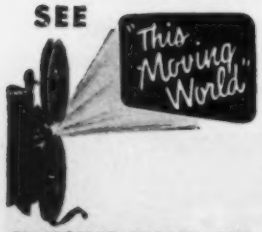
selected for Quality and Dependability



Products bearing these familiar trademarks have all established enviable reputations for quality and dependability.
These manufacturers *continue* to procure castings by National—one of the Nation's largest founders.

National's unparalleled experience in producing malleable, heat-treated malleable, and steel castings is at your disposal. Sales offices and engineering facilities are located at all five strategically located plants. A-5346

PLANTS LOCATED IN Sharon, Pa., Cleveland 6, Ohio, Indianapolis 6, Ind., Melrose Park, Ill., and Chicago 50, Ill.



A 16mm Technicolor film. Narrated by Edwin C. Hill, this 27-minute film tells how malleable iron is made . . . tested . . . used . . . how its production economy, ductility, machinability, toughness will give you a better finished product. Available for group showings.

NATIONAL Products FOR TRANSPORTATION AND INDUSTRY

NATIONAL MALLEABLE and STEEL CASTINGS COMPANY
CLEVELAND 6, OHIO Est. 1868

Miniature 4 PDT Relays

Only 1.6 cu in. in size and 3.76 oz. in weight, with operational shock resistance to 50 G and higher, new miniature, hermetically sealed, aircraft type 4 PDT relays have temperature ranges from —65 to +200 C., inter-electrode capacitance less than 5 micro-microfarads contacts to case, and less than 2½ mmf between contacts, even with plug-in type relay and socket. Vibration range is from 0 to 500 cycles per second and upward at 15 G without chatter. At 30 G operational shock resistance, sensitivity approaches 100 miliwatts.

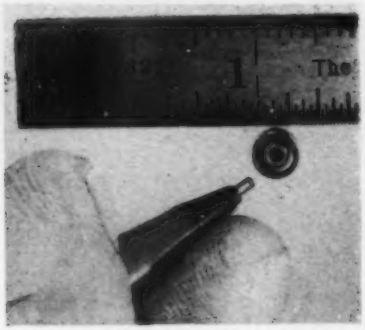
With contact ratings available through 7.5 amp resistive for 100,000 cycles (30 amp resistive for 100 cycles) at 30 v., d-c or 115 v., a-c, series R relays have been tested at 10 amp resistive for 100,000 cycles, and 30 amp resistive for 100 cycles. Contact resistance at the end of the tests was less than 0.030 ohms. Coil resistances up to 50,000 ohms can be supplied, as well as a variety of mounting arrangements.

The Hart Mfg. Co.,
110 *Bartholomew Ave., Hartford, Conn.*

Miniature Sealed Ball Bearing

Said to be the smallest sealed ball bearing ever designed, a new addition to the RMB Filmoseal series measures 0.1969 in. O. D., and has a bore of 0.0591 inch.

Feature of the bearing is a capillary film of lubricating oil which forms between the tapered outer surface of the inner race and the edge of a precision closure. This film of oil seals



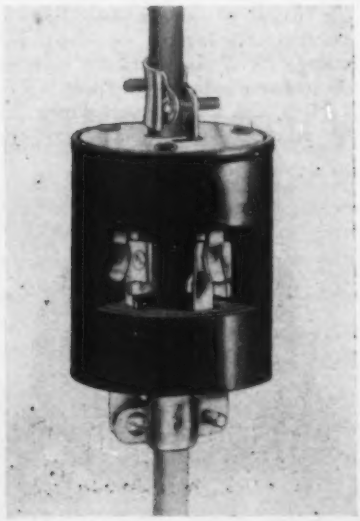
the bearing against dirt and moisture, and prevents loss of the lubricant, without any significant increase in frictional torque. It also adjusts to variations in pressure and temperature.

The filmoseal series now includes 11 sizes, ranging up to 0.8661 in. O. D., and are recommended for indicating and recording meters, precision instruments, computers, and any small mechanism where low torque and long life with a minimum of attention are required.

Landis & Gyr,
45 West 45th St., New York 36, N. Y.

New Interlocking Electrical Connector

Designed for heavy industrial use, a new principle in interlocking electrical connectors is interchangeable with all other interlocking makes. The cutaway photo shows the principle in action. Special right-angle lugs at the tips of the female contacts engage and support the male blades, giving a strain-proof, double-locked connection. This feature is used with an all rubber



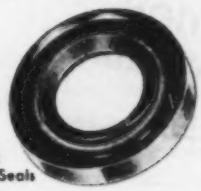
You can trust a TROSTEL seal

Leather Oil Seals

Automatic Control eliminates the human variable

Leather Packings

Synthetic Rubber Packings



Synthetic Rubber Oil Seals

It's human nature to have occasional "off days" . . . as your own quality control engineers will testify.

Here, at Trostel, we keep quality from getting a personal bias . . . by using specially developed *automatic* production machinery like the Trostel-designed multiple-die hot molding "consoles" pictured above.

These machines eliminate the possibility of human error in calculating and measuring critical time-pressure-temperature cycles. They do a precision job . . . automatically, unfailingly.

Our employees find this arrangement makes their work easier. Our customers know it results in packings and oil seals of *consistent quality* regardless of the day of the week or the time of day they are made.

It's another good reason why: "You can trust a Trostel seal."

Illustrated Bulletin On Request

ALBERT TROSTEL PACKINGS, LTD., Lake Geneva, Wis.

Formerly Division of Albert Trostel & Sons Co., Milwaukee, Wis.

BRANCH OFFICES
NEW YORK
LOS ANGELES
SAN FRANCISCO
SEATTLE · HOUSTON
WORCESTER, MASS.

TROSTEL QUALITY

TROSTEL packings

O & S SELF-LUBRICATING BEARINGS

WRITE TODAY FOR LITERATURE OR SEND PRINTS-SKETCHES-DETAILS

NeverOil SINCE 1913

O&S BEARING & MFG. CO.

777 W. EIGHT MILE ROAD • WHITMORE LAKE, MICHIGAN

body to eliminate chipping and broken connections.

The new connector is offered in five different models: 2 wire, 3 wire, 4 wire, and are rated for 10 and 20 amp service.

Rodale Mfg. Co., Inc., Emmaus, Pa

Gasket Has Compressibility And Heat Resistance

Asbestoprene, a new gasket material developed from asbestos and neoprene, has the advantage of combining compressibility with heat resistance. In addition, it is said to have better dimensional stability, does not cause corrosion, and is resistant to oils, water, gasoline, and anti-freeze solutions.

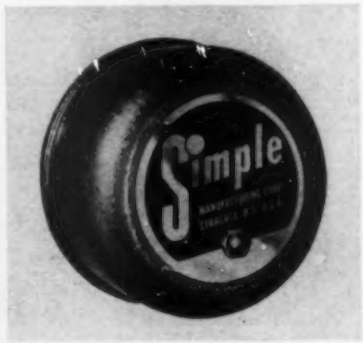
Physical properties are: Tensile strength: 1,500 psi min. in the machine direction and 500 psi min. in the cross-machine direction. Compressibility: 20-30 percent at a loading of 1,000 psi. Recovery: 40 percent minimum. Burst strength: 130 lb per ☆ in. gage. Oil resistance: a 90 percent minimum retention of tensile strength, and 5 percent maximum thickness change after 5 hours immersion at 300 F.

Victor Mfg. & Gasket Co., 5752 Roosevelt Rd., Chicago, Ill.

Precision Pressure Switch Has Many Applications

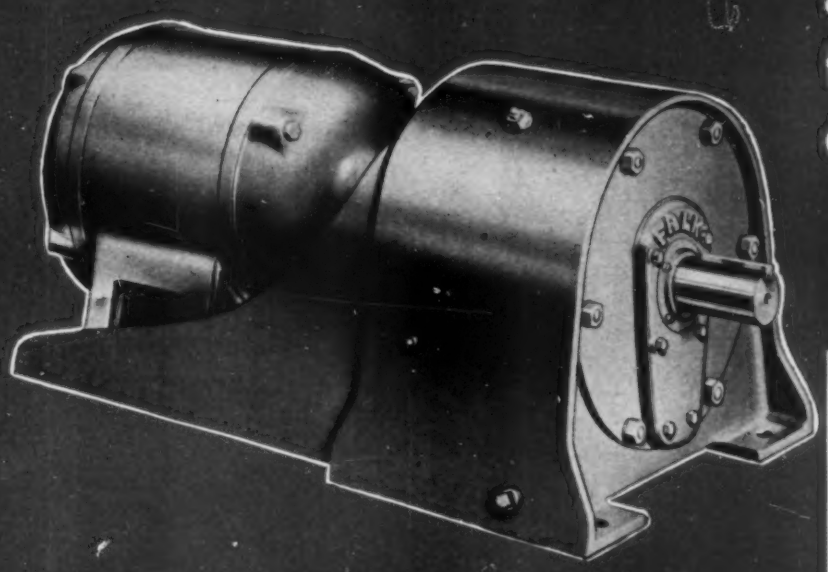
An adaptation of the Bourdon tube principle, with no wearable moving parts, this new type precision pressure switch is suitable for use on water, air, or hydraulic pressures. The manufacturer claims that the switch takes the place of a complete line of switches, eliminating inventory and storage. It is also rustproof and has no rubber diaphragm to crack.

High and low pressure limits can be adjusted independently to any



Choose the All-Motor type,

ALL-STEEL FALK Motoreducer



...with complete foot-mounted motor of ANY make ANY type ANY speed

Every FALK motoreducer has these "IN-BUILT" FACTORS

1 **All-steel Housings.** Unbreakable, strong, rigid. Generous overhung load capacities provided by wide bearing spans, large shafts and bearings.

2 **Streamlined inside and outside.** Smooth, clean surfaces; machine welded construction conforms to NEMA motor frames.

3 **Sealed Housings.** Dual closures and one-way vents keep oil *in*, dust and moisture *out*. Units are splashproof, leakproof, dustproof.

4 **Positive Lubrication.** Large sump capacity ...oil-tight construction assures clean lubricant...direct dip of revolving elements provides positive lubrication at all speeds.

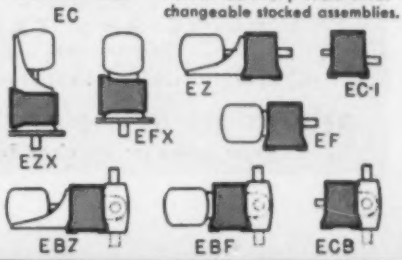
5 **Wide Speed Range.** Selective ratio combinations provide output speeds from 1.5 rpm to 1430 rpm with stock gears.

6 **Precision Gearing.** Heat-treated alloy steel, precision cut and shaved helical gearing throughout...quiet-operating crown shaved pinions...taper bored gears for easy ratio changes.

• • •

EC

The basic E design permits maximum use of standardized parts . . . closer control over materials, processing, inspection and assembly . . . resulting in faster delivery from interchangeable stocked assemblies.



Its exclusive, superior features mean LONG-RANGE ECONOMY!

The FALK all-steel, All-Motor type Motoreducer provides superior features and advantages found in no other reduction unit. Here is the only compact motorized reducer with a separate foot-mounted, resilient Steelflex coupling-connected, standard motor *without modifications!* It accommodates *any* make, type, or speed of motor within the AGMA rating of the unit.

The simplified construction of the FALK All-Motor type Motoreducer means real long-range economy. The assembly is highly versatile; it permits the use of special purpose couplings, brakes, fluid drives or other adaptations without modification of reducer or motor other than the addition of the special features. Standard motors from manufacturers' field stocks are always available without costly delivery delays or special motor or shaft modification.

When you choose a FALK All-Motor type Motoreducer, you get the utmost in design and dependability of performance—plus the greatest possible dollar-for-dollar value throughout its traditionally long life ... Available in standard ratios for stock shipment. Write for Bulletin 3104.

FALK ...a good name in industry

THE FALK CORPORATION 3001 W. Canal St. Milwaukee 8, Wis.

Socket Screws
• Use socket screws made by the most modern method—double extruded for extra strength and accurate forming. Physical qualities of the steel are actually improved by the Kaufman Process of manufacture. True hex sockets, perfectly concentric, are *clean* all the way. In plain, knurled or flat heads, Cleveland Socket Screws are fasteners that give you extra value without extra cost.
Cleveland has specialized for 37 years in making Cap Screws (all standard heads), Set Screws and Milled Studs.
CLEVELAND *Top Quality* FASTENERS
DOUBLE EXTRUSION

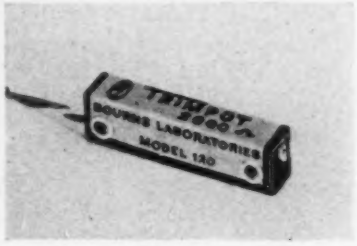
range within 100 lbs., including fractions of an ounce. For pressures over 100 lb., an interchangeable unit can be installed with a single screw.

No lubrication is necessary. The switch has a life expectancy of 1,500,000 operations and a rating of 110 v a-c, ½ hp. The unit measures 3 in. in dia. by 2 inches.

Simple Mfg. Corp.,
214 Temple St., Syracuse, N. Y.

Sub-Miniature, Wire-Wound Potentiometer

Accurate adjustments are made on a new miniature wire-wound potentiometer by turning an exposed slotted shaft with a screwdriver. Designed for precise circuit trimming in miniaturized equipment, the model 120 Trimpot can be mounted individually



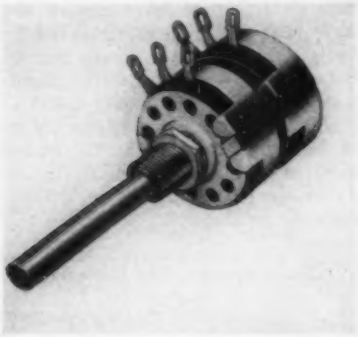
or in stacked assemblies, and settings are maintained during shock, vibration, and acceleration.

Characteristics: Resolution as low as 0.25 percent is obtained over the twenty-five turn adjustment range. Good electrical characteristics are achieved through the use of precious metal contacts and precision wirewound resistors. Size: $\frac{9}{32}$ in. x $\frac{5}{16}$ in. x 1¼ in.; Power: ¼ watt; Standard Resistances: 250, 500, 1,000, 2,000, 5,000, and 10,000 ohms; Acceleration: 100 G's; Vibration: 5—10 G's, 0-1000 cps.

Bourns Laboratories,
6135 Magnolia Ave., Riverside, Calif.

Molded Composition Potentiometers Mounted in Tandem

Dual type AB 2-watt molded composition potentiometers, consisting of two units mounted in tandem and controlled by the rotation of one shaft, are designed for industrial, laboratory, radio, television, and electronic service applications. The resistance element is a thick, solid-molded ring, heat treated under pressure, not a sprayed



film or paint-type resistor. The new dual units have a 2 in. long, round shaft, and independent electrical connections.

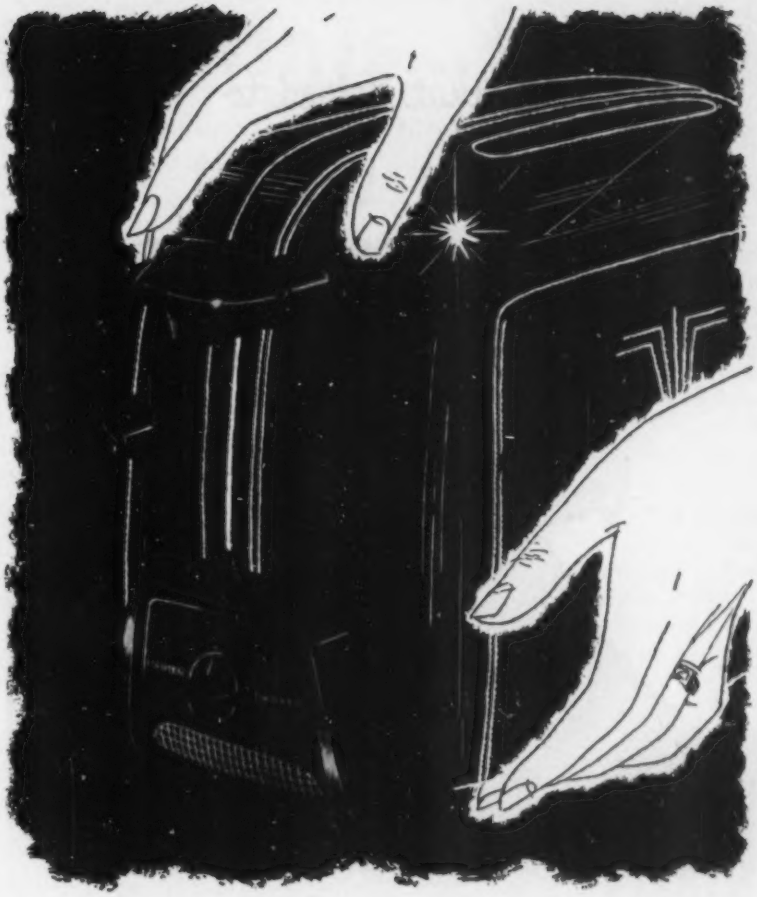
These noise-free potentiometers are available in the linear curve type, with seven resistance values available, ranging from 10,000 ohms to 1.0 megohm.

Ohmite Mg. Co.,
4835 *Flournoy St., Chicago, Ill.*

Vibration Isolator Absorbs Heavy Shock Loads

Electronic equipment, delicate instruments, aircraft engines, and a wide variety of equipment can be protected from shock and vibration with isolators rated from ½ lb. loads to large 500-1000 lb. loads.

Called the Cohrlastic DS mount, it is of the non-linear type, and has a decreasing slope of its load-deflection curve, absorbing small vibrations with



put colorful products in your customer's hands

The recent trend toward brighter colors in the kitchen led one of the nation's foremost manufacturers of toasters to consult PRP. Toaster knobs and handles were requested in red, yellow and green. For years all such parts had been made of brown or black phenolic plastic. A new, colorful, heat-resistant substance was needed . . . Melamine plastic was selected because of its heat resistance and wide range of colors. Quantity parts were supplied, helping the toaster to climb in popularity and thus meet the modern trend . . . Whatever your problem in plastic parts—from appearance to precision molding—PRP stands ready to work with you toward improving your product and profits.

when you look for plastic moldings, look first to **P**lastic **R**esearch **P**roducts, Urbana, Ohio

PRP

-the Process that Helped to

MICROCAST PRECISION CASTINGS PROCESS

SPEED UP

JET ENGINE PRODUCTION

Complicated power blades and buckets for jet engines require the use of high-melting-point alloys that are slow and costly to produce by ordinary methods of manufacturing. The Microcast Process of investment casting produces these parts for use as cast, reducing machining and grinding operations to an absolute minimum. This process is particularly well suited to similar applications requiring the use of high-temperature alloys. Let us show you how MICROCAST parts can fit into your product's design.

Write for booklet and information on new color movie.

MICROCAST DIVISION

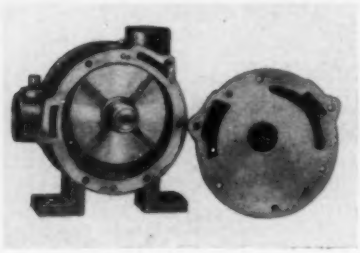
austenal laboratories, inc.
224 East 39th St., New York 16, New York
7001 South Chicago Ave., Chicago 37, Ill.

little deflection or movement of the equipment. At low loadings it is relatively stiff. At high loadings, such as heavy shock, when a piece of equipment is dropped, the mount serves as a soft cushion, absorbing the energy of impact, and returning the equipment to its original position. In addition, the mounting does not develop resonant frequencies.

The Connecticut Hard Rubber Co., East & New Sts., New Haven 9, Conn

Pumps Require No Lubrication

A new design of oil-less pressure and vacuum pumps, which end air contamination dangers because they run completely dry, have applications with food handling equipment, paper manufacturing, textiles, graphic arts



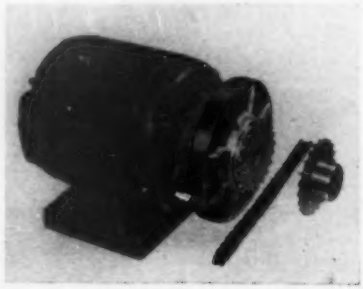
and any other use where possible oil contamination is a problem.

Equipped with lifetime-sealed bearings, the pumps require no lubrication, and have a range up to 11.5 cfm, 23 inches vacuum and 21 psi pressure. Pump speeds are up to 1,750 rpm.

Leiman Bros., Inc., 102 Christie St., Newark 5, N.J.

Easily Installed Fluid Coupling

A fluid coupling, no larger in diameter than the standard motor, and adding only ¼ in. to the length of the motor, can be installed quickly, and may be used for such applications as:



To get better prints... faster

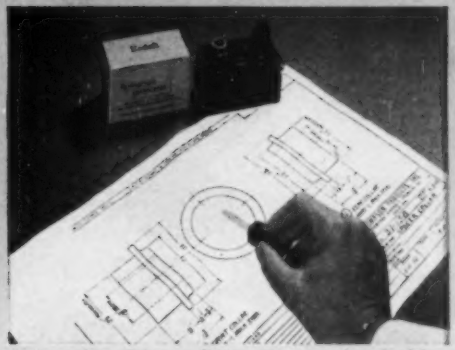
Tapco Plant, Thompson Products, Inc. uses Kodagraph Autopositive intermediates in print production.

The Tapco Plant knows full well that illegible shop prints pave the way for costly reading errors; knows, too, that Kodagraph Autopositive intermediates are low-cost insurance against such a possibility.

It therefore reproduces its more critical and complex jet and valve drawings on Kodagraph Autopositive Paper Translucent and thus obtains—quickly and easily—sparkling "masters" for print-making which have dense photographic black lines on an evenly translucent, premium-quality paper base; *which* will produce highly legible whiteprints time after time at *stepped-up* machine speeds.

Extremely fine-detailed drawings are reproduced on Kodagraph Autopositive Film, which captures the faintest detail . . . keeps close lines from "filling in" . . . and produces top-quality photographic intermediates which have extremely fast print-back speeds.

No negative step . . . no darkroom handling. Kodagraph Autopositive Paper and Film are handled in exactly the same manner . . . produce positive photographic intermediates *directly*. First, they are exposed in one of the Tapco Plant's direct-process machines—or in a photocopy unit. Then, they receive standard photographic processing. A fast, convenient room-light operation all the way. And no new equipment needed.



Autopositive intermediates save creative drafting time. Tapco Plant makes necessary changes in its basic designs without costly redrafting by (1) making Autopositive prints of the original drawing; (2) removing the unwanted detail from the Autopositive reproduction with eradicator fluid. Then, the draftsman has only to add the new detail . . . and a print-making master is ready. *One* which will produce highly legible prints without confusing "ghost" images in the eradicated area.

Autopositive reclaims "unprintables." Many old drawings that have lost line density or are soiled or torn are transformed into print-making masters by reproducing them on Autopositive Paper or Film. Stains and crease marks are dropped out . . . weak detail is made more legible—saving hours of redrafting. Autopositive Paper is also used to duplicate a variety of office records, non-translucent vendor prints, etc.

Kodagraph Autopositive Materials

"THE BIG NEW PLUS" in engineering drawing reproduction

MAIL COUPON FOR FREE BOOKLET

EASTMAN KODAK COMPANY 15

Industrial Photographic Division, Rochester 4, N.Y.

Gentlemen: Please send me a copy of your illustrated booklet giving the facts on Kodagraph Reproduction Materials.

Name_____ Position_____

Company_____

Street_____

City_____ Zone_____ State_____

Kodak
TRADE-MARK

In addition to supplying wire cloth in bulk, a fast-growing division of our company specializes in the fabrication or assembly of parts made from wire cloth. Many companies who formerly fabricated their own mesh parts now avail themselves of this service. After all, we know wire cloth—we've been making it for more than 75 years. We have the facilities, the skilled help, and the experience necessary to turn out these parts accurately and in small lots or in production quantities to meet your production schedules.

Some of our recent jobs are illustrated above. Perhaps one or more of these comes close to something you're working on right now. Write us giving complete details and specifications. If desired our experienced engineers will work with yours in the design of the part so as to make the most effective and economical use of the wire cloth. We shall be happy to quote on your requirements.

NEWARK for ACCURACY

We can furnish wire cloth woven from all commercially used metals. Sizes range from 4 inches (space cloth) to 400 mesh.

Newark Wire Cloth COMPANY

351 VERONA AVENUE • NEWARK 4, NEW JERSEY

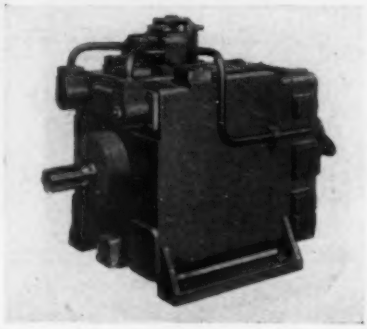
crane or trolley drivers, conveyors, looms, or printing presses.

Using new silicone fluids, the manufacturers claim that the coupling is compact, trouble-proof, and leak-proof. The unit is furnished complete with a flexible coupling, or a V-belt pulley for attaching to the driven shaft, giving smooth acceleration of loads, and preventing overload of the motor. The coupling is available in sizes from $\frac{1}{4}$ hp to 4 hp at 1800 rpm.

L & S Industries, Box 577 Norwalk, Calif.

Variable Delivery Hydraulic Pump

Suitable for either open or closed hydraulic circuits, these heavy-duty, positive displacement, axial piston type pumps and motors are particularly adapted to heavy machinery drives requiring precise control of torque, acceleration and deceleration, speed, or reversal. Hydraulic motors



in this series feature: quick reversal under full load, and run at very slow speeds under full torque.

Applications include: marine steering gears; winches and hoists; draw bridge lifts; extra large presses and machine tools; rotary machine drives; steel mill billet gougers and flying shears.

These units are available in ten sizes with capacities of 28 to 2300 gpm at rated speeds, and 50 to 4000 hp in the pressure range of 2000-3000 psi.

Waterbury Tool, Div. Vickers Inc., Waterbury, Conn.

Midget Adjustable Fastener

Weighing only $\frac{1}{2}$ oz. and held in a $\frac{3}{4}$ in. long housing, this miniature fastener is adjustable to door frames varying from 0 to $\frac{3}{32}$ in. thick. Each pawl can be adjusted for a $\frac{9}{32}$ in. variation in frame thickness. Installation is

Specify

GITS *Unit* SEAL

Result:

Economy

"Economy... counts not in savings but in selection."—*Edmund Burke*

Economy through Efficiency

Gits Unit Seal proves itself in dependable performance over a wide range of operating conditions—including extra-high speed, heat and pressure applications. Operation at peak efficiency always means dollars-and-cents savings.

Economy through Adaptability and Versatility

Gits Unit Seal fits many applications as a standardized item actually carried in stock. You harness the savings of mass production to your own specific needs. Gits Unit Seal already has wide application in the following fields: Washing Machines, Disposal Units, Gear Motors, Speed Reducers, Aircraft Turbine Pumps, Accessory Drive Units, Jet Propulsion Units, Electrical Power Equipment, Automotive Accessories, Business Machines, Standard and Special Machine Tools.

Economy through Long Life

Gits Unit Seal is designed for maximum life in any recommended application. Here's the real "proof of the pudding" in saving money.

Write Today For FREE Illustrated Brochure, or send us your seal problem. Our experienced engineering staff is at your service.

Cartridge Seal requiring only 25% more space than lip-type seals.

GITS BROS. MFG. CO.

1838 S. Kilbourn Avenue Chicago 23, Illinois

SHENANGO Centrifugal CASTINGS ... KEY TO SAVINGS

LEARN WHY... **SHENANGO**

MEEHANITE METAL BAR STOCK

means superior quality parts!

THERE are many reasons why Shenango tubular and solid bar stock is preferred for bearings, bushings, pump parts, liners, sleeves, gears, dies, gauges, and other common and special parts. Here are a few:

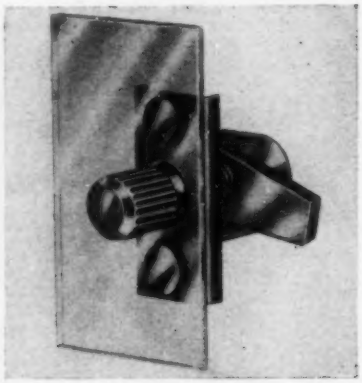
FIRST, centrifugally cast Shenango tubular bars assure more uniform pressure-dense grain, and complete freedom from blowholes, sand inclusions and other similar defects. They are better able to withstand friction, abrasion, and all kinds of stresses.

SECONDLY, both solid and tubular bars are made of superior, scientifically controlled Meehanite Metal. The metallurgical structure of Shenango Meehanite Metal is predetermined and controlled throughout the foundry operations, to produce the best quality bar stock available. What's more, machining speeds can be increased, and a smoother, finer finish is assured.

Get all the facts
SEND FOR BULLETIN NO. 152

SHENANGO-PENN MOLD COMPANY
Centrifugal Castings Division
Dover, Ohio
Executive Offices: Pittsburgh, Pa.

SHENANGO
ALL RED BRONZES • MANGANESE BRONZES • ALUMINUM BRONZES
MONEL METAL • NI-RESIST • MEEHANITE METAL



accomplished by slipping the knurled activating knob through a hole in the door and attaching with two rivets or spot welds. No further assembly is necessary.

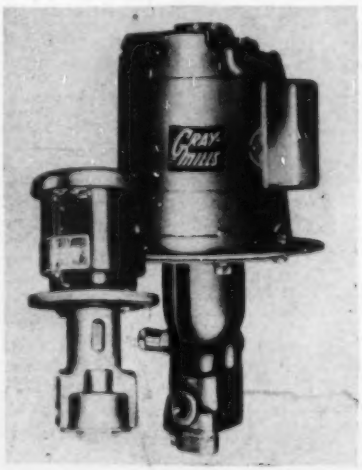
Turning the knob sets the pawl at the proper contact distance for locking against door frames of different thicknesses. Spring tension holds the pawl at the selected position, and pressure may be brought against a gasket or frame by more turns on the knob.

South Chester Corp., Southco Division, Lester, Pa.

Small, Self-Priming, Gear Pump

Having a fluid delivery of 1, 2, and 3 gpm with pressures to 100 psi, a new line of gear pumps is available with motor sizes of 1/25, $\frac{1}{4}$, $\frac{1}{8}$, and $\frac{1}{2}$ hp.

Designed for coolants, oils, solvents, emulsions, machine tools, circulating systems, and small sprayers, the pumps are self-priming, and directly connected to face mounted motors. Relief valve, inlet filter, and various mounting flanges are optional. The



pumps are mounted vertically, and either immersed in shallow tanks or with an inlet pipe dropped to the liquid.

Graymills Corp.,
1960 *Ridge Ave., Evanston, Ill.*

Miniaturized 400 Cycle Motor Generator

Miniaturization of control motor-generator and motor generator gear train combinations for servomechanisms has been made possible with the design of a new 400-cycle motor-generator that weighs four ounces and measures 0.9 in. in diameter.

Phase voltage of the motor is 26 volts with a maximum stall power of

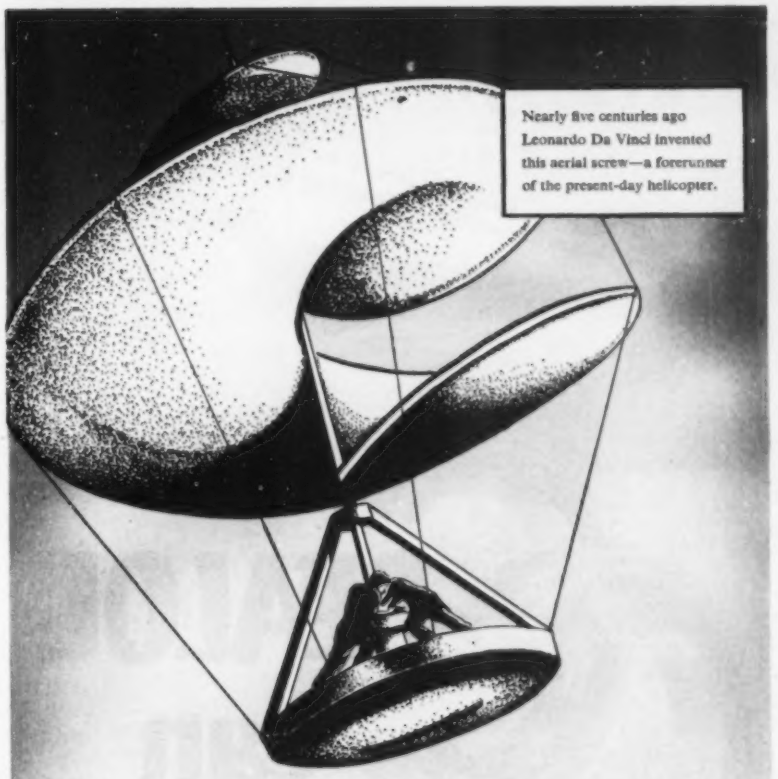
2.6 watts per phase, and a minimum stall torque of 0.3 in.-ounces. Output of the generator is 0.34V/1000 rpm, with an excitation power of 2.0 watts maximum. Generator characteristics also include a 5 deg phase shift working into a 100,000 load, and a 20 mil maximum null with a 10 mil maximum swing.

Transicoil Corp., 107 Grand St., New York 13, N. Y.

Warning Signal Mounted In Flow Switch

Specially designed for use in fuel pump lines of modern aircraft, this flow switch automatically sounds a warning signal whenever fluid flow falls below a predetermined value. Light in weight, small size, and of heavy construction, this switch is unaffected by pressure or temperature changes.

As fluid flow falls below a predetermined value, restoring and calibrating magnets force a pivoted aluminum vane toward a closed circuit position,



...out of this came Aviation

...an industry with imagination

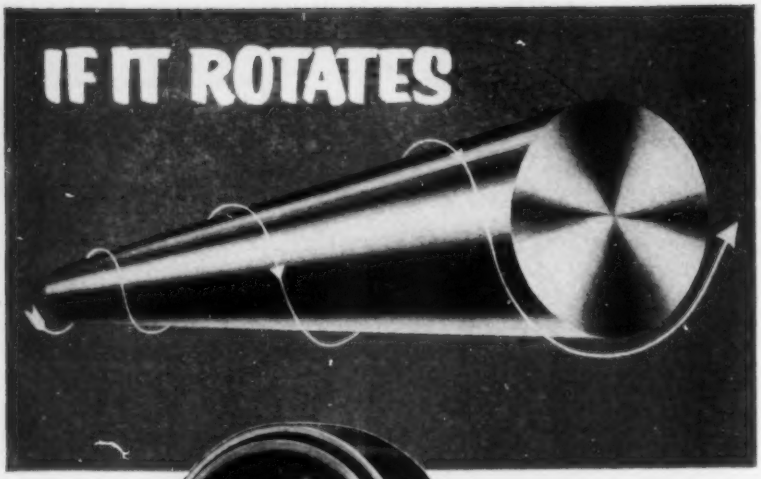
To serve this great industry there are many manufacturers with imagination and vision. Indiana Gear is such a company—a group of able craftsmen equipped with the best of tools and machines—producing the finest in precision parts. At I.G.W. we accept the challenge of this and all other precision industries. We will match their visionary design with creative production.

Indiana Gear fabricated this large steel ring gear for the main transmission of a recent model Sikorsky Helicopter without grinding and without heat treat distortion. Originally, the helical teeth on this gear were ground, but a necessary power increase overloaded the part and it failed.

It was assumed to be impossible to successfully heat treat the unground teeth, but I.G.W. produced the part without distortion and the gear operated successfully.

INDIANA GEAR

INDIANA GEAR WORKS, INC. • INDIANAPOLIS 7, INDIANA



SEALOL can seal it!

Pumps, fluid transfers, flexible joints, hydraulic motors, hydraulic actuating devices . . . these and countless other products depend on Sealol for their maintenance-free performance. Sealol Balanced Pressure Seals are usually one of the smallest components in the equipment they serve . . . yet what a difference Sealol Seals make in operating efficiency!

Sealol Seals are handling pressures up to 1500 psi, rubbing speeds to 15,000 FPM, operating temperatures to 500° F. The Sealol *balanced pressure principle* insures close control of face pressure at the point of sealing — resulting in low friction, low torque, minimum heat, and low power loss. Sealol performance improves product performance . . . and reduces product maintenance.

Let's talk it over. Send for NEW Bulletin 7 giving complete details on Sealol Balanced Pressure Seals — or write giving details on your problem for engineering recommendations. Sealol Corporation, 5 Willard Avenue, Providence 5, R. I.

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Chicago • Cleveland • Houston • Los Angeles • Philadelphia
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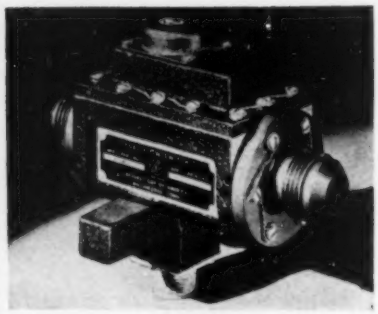
SEALOL

THE BALANCED PRESSURE SEAL



actuating a hermetically sealed glass switch which operates a warning signal. The actuating position of the switch can be set to indicate flow conditions at different rates, depending upon the requirements.

Revere Corp. of America, North Colony St., Wallingford 2, Conn.

Miniature, Hermetically Sealed DPDT Relay

Miniature, hermetically sealed, double pole, double throw relays, weighing only 3½ oz. and designed to operate through a wide range of environment, will withstand high acceleration, vibration, shock, and tumbling. They meet the shock requirements of MIL-E-5400 and will withstand continuous acceleration of 50 G. without failing.

Certain contact combinations can be

furnished for this relay with a required coil power as low as 20 milliwatts, and any relay in this series can be obtained with a coil resistance as high as 15,000 ohms.

A relay of this PR9100 series has been tested in excess of 1¾ million operations carrying a 3 ampere resistive load at 28 volts d-c.

More information on this and other types of relays may be obtained from the manufacturer.

Phaostron Co., 151 Pasadena Ave., South Pasadena, Calif.

MEETINGS

July 24

MALLEABLE FOUNDERS' SOCIETY—Western Sectional Meeting, Hotel Drake, Chicago, Ill.

August 17-19

SOCIETY OF AUTOMOTIVE ENGINEERS — International West Coast Meeting, Georgia Hotel, Vancouver, B. C., Canada.

August 19-21

WESTERN ELECTRONIC SHOW AND CONVENTION — Civic Auditorium, San Francisco, Calif.

September 1-4

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS—Pacific General Meeting, Hotel Vancouver, Vancouver, B. C., Canada.

September 14-17

SOCIETY OF AUTOMOTIVE ENGINEERS—National Tractor Meeting and Production Forum, Hotel Schroeder, Milwaukee, Wis.

September 28-30

NATIONAL ELECTRONICS CONFERENCE — Annual Conference, Hotel Sherman, Chicago, Ill

September 29-October 1

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS—Middle Eastern District Meeting, Daniel Boone Hotel, Charleston, West Virginia.

October 8-9

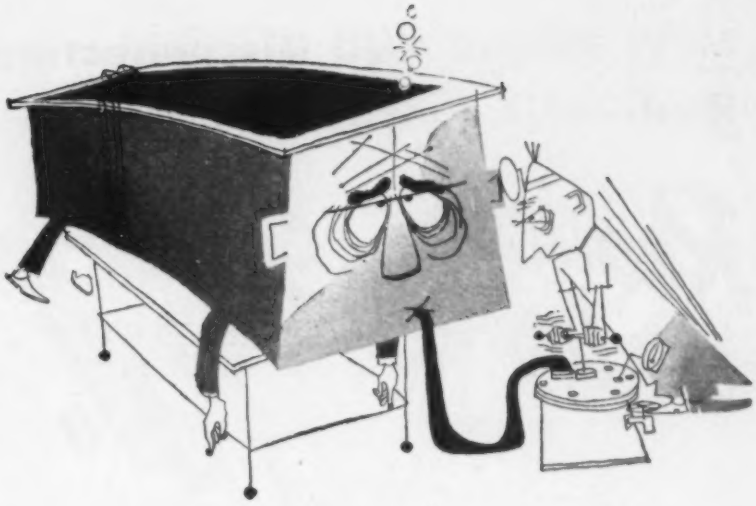
NATIONAL CONFERENCE ON INDUSTRIAL HYDRAULICS — Annual Meeting, Hotel Sheraton, Chicago, Illinois.

October 26-30

NATIONAL PAINT, VARNISH, AND LACQUER ASSOCIATION—Annual Convention and Paint Industries Show, Chalfonte-Haddon Hall, Atlantic City, N. J.

October 29-30

SOCIETY OF AUTOMOTIVE ENGINEERS — International Production Meeting, Royal York Hotel, Toronto.



has **coil-itis*** cramped your production flow?

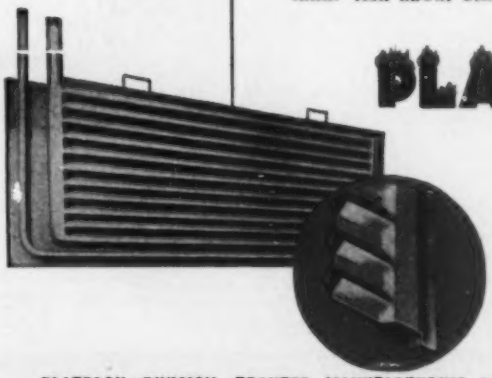
It's a waste of costly time to pump out the solution every time your process heating and cooling tanks get indigestion due to pipe coil troubles. You can save this cost and eliminate production bottlenecks by replacing the pipe coils with Platecoils. Platecoils can be removed and replaced **without dumping the solution.** They simplify maintenance and save hours of downtime. They heat or cool 50% faster and take 50% less space in the tank. As revolutionary as the new wonder drugs, Platecoils cure production troubles involving heat transfer . . . and give profits a shot in the arm.

Write for bulletin P77 today!

PLATECOILS SAVE 50% IN HEAT TRANSFER COSTS

PLATECOILS TRIPLE PRODUCTION

At Continental Motors Corp., 3 crankcase sections can be cleaned at one time when Platecoils are used while only one crank case can be cleaned with pipecoils in the tank. Ask about other case histories.



PLATECOIL

REPLACES PIPE COILS

*Coil-itis — Diagnosed as tank heating and cooling problems. Platecoils — the prescription for solving pipe coil problems.

PLATECOIL DIVISION, TRANTER MANUFACTURING Inc., LANSING 4, MICHIGAN

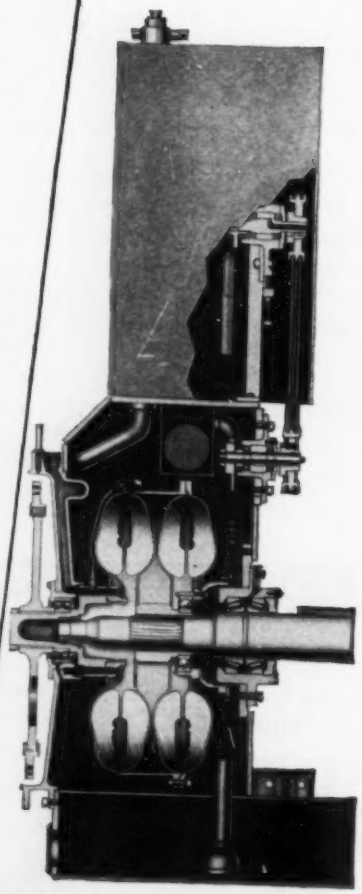
NEW Model HUD Disconnecting Hydraulic Power Take-Off . . .

Reduces Impact Shocks 70%

Doubling wear life on chains, clutches and running parts, drilling rigs equipped with the new Twin Disc Disconnecting Hydraulic Power Take-Offs have been running up outstanding service records during the past two years. Many rigs now drill deeper, more economically, because the new Twin Disc Model HUD allows the *full use of peak engine torque* . . . dampens starting shocks, stopping shocks and overloads. Through the complete Disconnect feature, the HUD acts as a master clutch.

Steady power transmission through Twin Disc HUD softens and controls speeds of acceleration and deceleration . . . to reduce impact shock—on power units *and* driven equipment—by 70% or more. Compounded drives can easily be synchronized—drum clutches can safely be engaged with engines idling, for smoother load pick-up—the range of available mud pump speeds and pressures can be greatly extended. Rig engines, free to run at their most efficient rpm, *prevented* from lugging or stalling under load, are assured of a longer, more serviceable, trouble-free life.

For complete information on how Twin Disc Disconnecting Hydraulic Power Take-Offs are adding efficiency to modern drilling rigs, contact your nearest Twin Disc Factory Branch, or write to the Hydraulic Division, Rockford, Ill.



Twin Disc Model HUD Disconnecting Hydraulic Power Take-Off—available in coupling sizes 21" and 27"; to handle 60 to 600 hp engines . . . operates with either cooling radiator or heat exchanger . . . incorporates shortened oil sump to fit rig design.

Built for a Long Life . . . Backed for a Lifetime

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CLUTCHES AND HYDRAULIC DRIVES

TWIN DISC CLUTCH COMPANY, Racine, Wisconsin • HYDRAULIC DIVISION, Rockford, Illinois

BRANCHES: CLEVELAND • DALLAS • DETROIT • LOS ANGELES • NEWARK • NEW ORLEANS • SEATTLE • TULSA

Catalogs and Bulletins

(1) SOLENOID VALVES—Automatic switch Co., Catalog 24 80 pp. Has general information and instructions for valve selection; flow charts for full area valves handling water, air, gases, and steam. Also, sections on: manual reset, and no voltage release valves; packless solenoid valves; packed valves; packless, midget and small sizes; three-way packless; 2 and 3-way pilot operated; 4-way packless, sleeve type, pilot controlled diaphragm operated valve. Has illustrations and engineering data on all valves.

(2) MILLIVOLTMETER TYPE INSTRUMENTS—Minneapolis Honeywell Regulator Co., Catalog 1053, 20 pp. Indicators; Indicating Electronic Controllers; and Excess Temperature Safety Cut-Off controllers. Data on operation and applications of on-off, two position, 3-position, and pulse type time-proportioning controllers, and information on primary measuring elements. Has many illustrations and diagrams.

(3) ELECTRICAL INSULATIONS—Johns-Manville Co., Booklet EL-40A, 32 pp. Complete information about electrical insulations made of purified asbestos, why they were developed, what their characteristics are, and where they may be used to advantage. Tables give test data on physical and electrical properties.

(4) MULTI-STAGE PUMPS—Peerless Pump Div., Bulletin B-1400, 12 pp. Illustrations, engineering data, and specifications for a line of 2, 3, 4, and 5-stage split-case pumps. The 2-stage have capacities to 3,000 gpm and head ranges to 800 ft.; The 3-stage have capacities to 1400 gpm and heads to 950 ft. The 4-stage have capacities

to 900 gpm and heads to 1600 ft; and the 5-stage have capacities to 300 gpm and heads to 1550 feet.

(5) TUBING—The Ohio Seamless Tube Co., Booklet 8 pp. Lists applications and typical specifications for such tubings as mechanical seamless, aircraft seamless, welded mechanical, and welded pressure types. Has illustrations of the shapes to which tub ing may be forged and fabricated.

(6) WIRE FORMING—Eastern Tool & Mfg. Co., Booklet, 24 pp. General information on wire forming; wire loops and slides; metal stamping; deep drawings; and plating and finishing. Has illustrations of facilities and products made.

(7) PRINTED ELECTRONIC CIRCUIT—Centralab Div. of Globe-Union Inc., Circuit guide No. 2. Lists 27 standard stock units. Complete circuits, components, and applications are shown. A group of components is replaced by one unit. Complete testing data is also given.

(8) SWITCHES—Carling Electric, Inc., Catalog B, 10 pp. Lists switches for: appliances; aircraft; automotive; electronic; marine; motor control; and special application for a-c or d-c. Has illustrations of all types, plus dimensions and complete specifications.

(9) ELECTROPLATED RHODIUM—Technic Inc., Data Sheet, 1 pp. Gives data on a method for electroplating rhodium to thicknesses up to 0.001 inch. Gives physical properties; electrical properties; corrosion resistance; hardness; electroplating specifications; thickness requirements; and all applications.

(10) BRONZE CASTING ALLOYS—American Manganese Bronze Co., Booklet, 48 pp. Called a "Reference Book on Bronze Casting Alloys," it gives general information on composition, characteristics, and applications of many of the common or typical alloys. Has index of specifications for common kinds of bronze castings; and an index of applications and characteristics of bronze alloys in cast form.

(11) SELF-ALIGNING ROLLER BEARINGS—The Torrington Co.,

MUELLER BRASS CO.

forgings

BRASS · BRONZE AND ALUMINUM

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PRECISION MACHINED TO YOUR SPECIFICATIONS

IT'S YOURS! NEW 32-PAGE FORGINGS ENGINEERING MANUAL. WRITE TODAY

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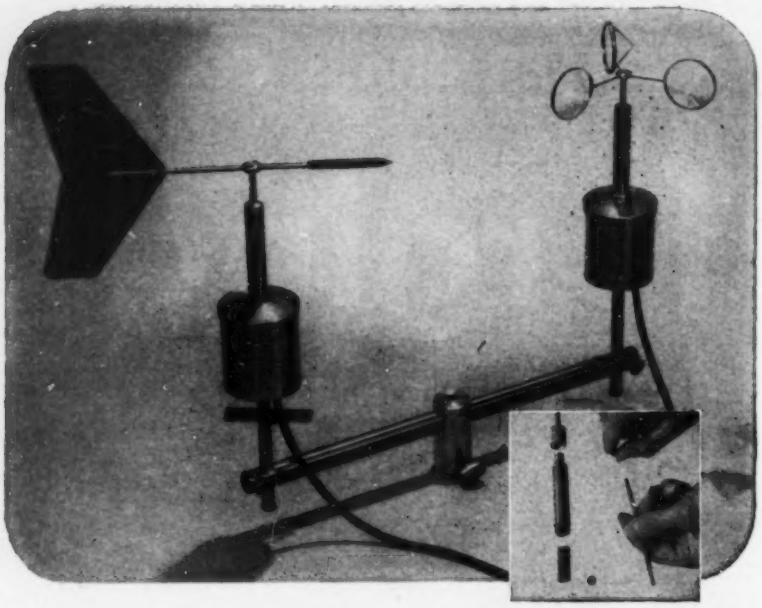


Micro Bearings Measure Up

. . . in this electronic "Climate Survey System"

To combat the problem of smog and atmospheric pollution, Beckman & Whitley, Inc., of San Carlos, California recently introduced this electronic recording anemometer and wind direction instrument, called a "Climate Survey System." It is used to measure the extremely slow air movements associated with such conditions. Prime requirements include an exceptionally low stall point, constant operation throughout a wide range of temperatures, and satisfactory linear recordings despite varying speeds.

We are proud that Micro Ball Bearings measure up in every respect. Used at both ends of the anemometer drive shaft, Micro bearings combine low friction with smooth performance under varying temperature and wind conditions. Processed to a true Micro-finish, they help insure complete uniformity in every instrument.

If you have a problem that calls for savings in friction, weight or space, it will pay you to contact Micro.

Micro PRECISION INSTRUMENT **BALL BEARINGS**

NEW HAMPSHIRE BALL BEARINGS, INC. 3 Main Street, Peterborough, N. H.

CHECK THESE MICRO ADVANTAGES

• Precision Tolerances
Fully processed to a true micro-finish. Tolerances are ABEC-3 and better.

• More Sizes and Types
Available in 135 sizes and types down to .04" bore, ⅛" O.D. Materials include chrome, stainless steel and beryllium copper. Special items and materials considered.

• Engineering Assistance
Top staff of design engineers available to help customers at any time.

• Availability
Small-quantity orders for items in production are shipped either from stock or as the next run comes through. Large quantities are scheduled for earliest possible delivery prevailing at time of order.

Free Catalog
Send today for Catalog No. 53 which gives full specifications and application data on all types and sizes of Micro Ball Bearings.

Catalogs and Bulletins.....continued

Bulletin 200-C. Has spherical roller bearing width tolerance chart; thread, locknut and lockwasher data; and interchangeability chart. Also lists: life expectancy; capacity ratings; life factors; installation and service factors; speed data; loads; fits; and lubrication.

(12) GEAR SPEED REDUCERS—D. O. James Gear Mfg. Co., Catalog 40-c. Lists 130 sizes of continuous-tooth herringbone gear speed reducers with informative data on reduction gears ranging from ½ to 5000 hp, and ratios from 2:1 to 368:1.

(13) SHOCK MOUNTING SYSTEMS—Robinson Aviation, Inc., Bulletin 750, 16 pp. Illustrated the development of all-metal mounting systems for the maximum vibration isolation and shock protection of electronic equipment. Defines shock, vibration, and shows the effect of vibration on equipment. Has illustrations of all types of mounts.

(14) VALVES—Republic Mfg. Co., Catalog 352 A, 44 pp. Lists: needle, globe, plug, check, relief, and special valves, plus gage protectors and snubbers, bleeders, and AN vacuum control valves. Units are made of various metals and are suitable for instrumentation, aircraft, processing industries, and hydraulic systems. Details of construction are shown, plus complete specifications.

(15) DYNAMOMETER — W. C. Dillon & Co., Bulletin D4, 4 pp. Has complete information on the use of a dynamometer that measures traction, tension or weight. Has illustrations and specifications on various sizes with various capacities up to 100,000 pounds.

(16) RIVETING HINTS—The Hi-Shear Rivet Tool Co., 3rd Edition, 60 pp. Completely illustrated, explaining each step, it describes the hi-shear rivet, materials used, dimensions, hole preparation, riveting gun hints, rivet removal, and other information.

(17) MOTOR-GENERATOR REFERENCE BOOKLET — Allis-Chalmers Mfg. Co., Booklet 51R7933, 50 pp. Assists in the selection of motive power to handle most industrial applications. Has illustrations of various types, wiring diagrams, and engineer-

ing data on each type. Covers d-c motors; d-c generators; induction motors; all types of motor-generator sets; synchronous motors; and data on motors in general.

(18) PRECISION CASTING—Jelrus Precision Casting Corp., Booklet, 8 pp. Analyzes and describes typical applications and advantages of precision investment casting in ferrous and non-ferrous metals. A completely illustrated section describes in detail each step in the process.

(19) ALUMINUM SHEET & PLATE—Kaiser Aluminum & Chemical Sales, Inc., Handbook, 152 pp. Includes discussions of the properties of aluminum, applications of sheet and plate alloys, fabrication and finishing methods, plus tables covering availabilites, properties, and other information. One page is devoted to each standard alloy, giving mechanical properties and specific qualites.

(20) VACUUM TUBE ELECTROMETERS—Keithley Instruments, Booklet, 8 pp. Has 19 application diagrams, plus a full description of accessories, which permit measuring a wide range of d-c voltages, currents as low as 10^{-14} amp, and resistance to 10^{16} ohms.

(21) RUBBER LINED PUMPS—Denver Equipment Co., Bulletin P9-B8, 20 pp. Lists all parts, and shows in exploded views a line of rubber lined sand pumps, with capacities to 2400 gpm. Shows sectional views, lists clearance and foundation dimensions, specific gravity of pulps, friction of water in pipes, capacities, a motor selection table, and installation and maintenance instructions.

(22) CONTROL RELAYS—Westinghouse Electric Corp.; Booklet B-5817. Application and design information on a new type N control relay, designed for remote control operation. Has 10 amp. open rating up to 600V and 6 poles, in any normally open or closed combination. Exploded view shows construction features.

(23) DRIPPROOF INDUCTION MOTORS—The Lima Electric Motor Co., Bulletin RS-2, 6 pp. Illustrations, plus an exploded view showing all

LEBANON Castings are at work

ON the lonely oil fields of the Saudi Arabian desert nine turbines break the stillness with their steady whine of work. These are Terry Steam Turbine Company's Type C.S. Turbines, and all the castings in these turbines are made by Lebanon Steel Foundry. Driven by waste gas from the oil fields, they power heavy-duty pumps that deliver 100,000 barrels of oil a day.

Operating at 280°F., 450 pounds pressure, the turbines, which are among the largest natural gas turbines in the world, develop a mighty 1940 H.P. at 4400 R.P.M. Terry Steam and their customer, the Arabian-American Oil Company, know that satisfactory service is doubly important when replacement parts are thousands of miles away and repairs are costly. You can be sure that these factors figured prominently in the selection of Circle L Steel Castings, products of true craftsmanship.

You should see — STEEL WITH A THOUSAND QUALITIES — A 37-minute 16 mm full color sound film on the making of steel castings. For information write: Dept. C, Lebanon Steel Foundry.

LEBANON Castings

CARBON, SPECIAL ALLOY AND STAINLESS STEEL

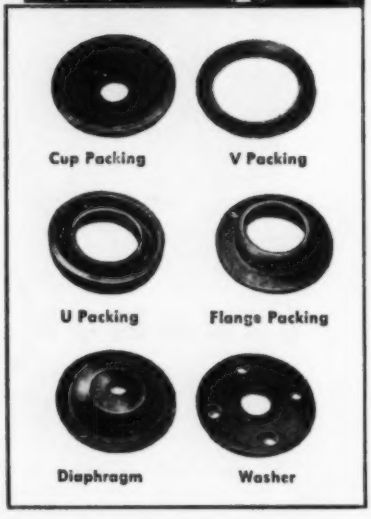
LEBANON STEEL FOUNDRY LEBANON, PA.

MARSH research leads again with a new *improved* quality impregnated mechanical leather!

Marsh leads in better Leather Packings, because –

- Only packing leather specifically tanned to Marsh rigid specifications is used.
- Marsh continuing research on impregnations and quality control give you new packing material values – to improve the efficiency and acceptance of your products.

Marsh research has developed new, tougher – wear, age and extreme temperature resistant – mechanical leather packings which combine resilience and tightness with low friction.



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FEATURES: Low coefficient of friction — both static and running, greater wear resistance, tighter sealing, better high and low temperature stability, improved lubrication potentials, longer life.

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parts, speed-torque curves, frame number charts, dimensions and specifications for motors from ½ to 150 hp, as well as complete descriptions of variations for optional mounting and special purpose applications.

(24) FLEXIBLE SHAFTING — Kupfrian Mfg. Co., Bulletin 5194, 10 pp. Has many illustrations showing typical shaft assemblies; flexible shaft couplings; coupling nuts; different types of casings; and illustrations of applications. Gives complete specifications for 14 different types.

(25) SILICONE RESIN — Dow Corning Corp., Booklet, 6 pp. Has tables of physical and electrical properties measured on silicone laminates made with a variety of glass cloth. Also has applications and recommended impregnating and laminating procedures, plus a graph showing the thermal life of the silicone laminating resins.

(26) MAGNETIC ANALYSIS COMPARATORS—Magnetic Analysis Corp., Bulletin 30, 4 pp. Illustrates and describes production and single frequency comparators for inspecting ferrous materials or parts, and the dual frequency comparator for inspecting both ferrous and non-ferrous metals.

(27) LOW VOLTAGE SWITCHGEAR—General Electric Co., Bulletins GEA-5915, and 5916, 32 pp. Has many illustrations of a line of low-voltage drawout switchgear, 600v a-c and below, with standardized compartment construction and new air circuit breakers. Continuous current ratings range from 15 to 400 amps.

(28) PRECISION METAL PARTS —The Torrington Co., Booklet, 4 pp. Illustrations of the many small parts that are made to close tolerances. Some of the parts described are: special pins and pivots; rotary swaged rods; screw driver blades; wires and tubing in all kinds of metals; mandrels; punches; abrasive points; and polishing wheels.

(29) MOTOR APPLICATION — The Louis Allis Co., Catalog, 24 pp. Having many illustrations and charts, it contains composite information and selection charts for all types of motors and illustrates typical applications of

the various types of motors. Has electrical selections chart for a-c and d-c motors; gearmotor selection; adjustable speed selection chart; and data on special motors.

(30) HIGH-PRESSURE HYDRAULIC CYLINDERS—The S-P Mfg. Corp., Catalog 103, 10 pp. Covers a new line of space-saving, high-pressure cylinders for working pressures up to 2,000 psi. Has illustrations, large cutaway views, and complete specifications for models available in 11 bore sizes from 1½ through 8 inches. Also has extensive pressure and flow data.

(31) FLOW METERS—Minneapolis-Honeywell Regulator Co., Spec. Sheets 241-247, 20 pp. Covers electric evenly graduated flow meter bodies and mechanical evenly graduated flow meters; square root flow meters, and liquid level meters. Includes many illustrations, plus construction and engineering details.

(32) TORQUE CONVERTERS — Allison Div. of General Motors, Booklets SA-1015 & 1018, 8 pp. Has complete specifications for the series 600 and 900 torque converters for heavy duty operation. Has cross-sectional views, engineering drawings, and extensive descriptive data.

(33) POWDER PRESSINGS—The United States Graphite Company, Engineering Handbook G-53, 44 pp. With the use of color diagrams, the method of producing powdered pressings is explained, and die design considerations are made clear. One page illustrates "do's and dont's" in the design of powder pressings. Other data includes tolerances, dimensional limitations, bearings loads and permissible speeds and clearances for pressed powder bearings, correct machining, the composition and properties of fifteen grades of both non-ferrous and ferrous powder pressings, and illustrations of pressed powder parts. Supplement A lists 132,000 different sizes and shapes of bearing and bushings for which this company has die sets already available. This supplement must be requested specifically.

(34) PRECISION ALUMINUM EXTRUSIONS—Precision Extrusions Co., Catalog, 96 pp. Under general information it gives the advantages of

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(35) MINIATURE SNAP-SWITCH—The Sessions Clock, Bulletin 101, 6 pp. Data on the construction and operational characteristics of the Tyni-switch. Has specifications, and a-c and d-c ratings. Has illustrations of all types.

(36) AUTOMOTIVE ELECTRIC EQUIPMENT—Westinghouse Electric Corp., Booklet B-5651, 36 pp. Discusses the characteristics of motors, controls, packaged drives, dynamometers, and other types of electrical apparatus. Each type of equipment is appraised in relation to its place in the production line. Design and test procedures are also described.

(37) MEASURING FLATNESS—Crane Packing Co., Bulletin L-404, 6 pp. In color, it illustrates and describes the measuring of surface flatness through light band reading. Interpretation of these readings are explained in detail. Also has particulars on a line of precison measuring and lapping equipment.

(38) DIAL THERMOMETERS—Taylor Instrument Co., Bulletin 98214, 24 pp. Describes the latest development in 6 in. dial indicators for temperature, pressure, and load applications. Has data and illustrations of features, dials and scales available, and different types of actuation. Recommended applications for each type are listed.

(39) AIR & HYDRAULIC COMPONENTS—Pathon Mfg. Co., Bulletin, 8 pp. Information on a line of air cylinders, hydraulic oil cylinders, and directional hydraulic control valves. Has illustrations and complete specifications for the various types of mountings of the cylinders, and all technical data for the control valves.

(40) MERCURY PLUNGER RELAY—Ebert Electronics Co., Booklet, 4 pp. Describes and illustrates seven different types of mercury plunger

relays with contact rating of 35 amp 115V, or 25 amp 230V. Has complete specifications on each type.

(41) TORQUE CONVERTER—Diesel Div., General Motors Corp., Booklet 6SA24, 8 pp. Has cutaway drawings, and curves showing hp characteristics of engines equipped with the converter. Explains operating principles, and shows application in various installations.

(42) CASTINGS & PATTERNS—Howard Foundry Co., Catalog, 72 pp. Has many illustrations showing the production of aluminum, magnesium, semi-steel, bronze, brass, and electric alloy steel castings. Has full page tables on: conforming specifications; nominal compositions and mechanical properties of aluminum base alloys, and similar tables for other materials.

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ENGINEERING ABSTRACTS

Ductile Welds In Zirconium

Abstracted from "Ductile Welds in Zirconium," by F. G. Cox, Murex Ltd., *The Welding Engineer*, April, 1953.

THE FUSION WELDING of zirconium without loss of ductility has hitherto been considered impossible. However, since ductile zirconium can be produced by melting it in an arc furnace in an atmosphere of pure argon, it was reasoned that it should be possible to weld zirconium in a similar atmosphere. Experiments conducted with argon-arc welding equipment in which some modifications had been made revealed:

(1) On sheets of 0.030 in. or thinner, welds made with direct current are definitely superior to those made with alternating current. When direct current is used for welding with the standard type holder, the only additional protection needed is an argon stream on the back of the weld.

(2) To weld zirconium sheets in thicknesses over 0.030 in. and up to ¼ in., it is necessary to shield the work in a much more exacting manner. All air must be excluded from the weld zone. It is not necessary, however, to purify the argon.

(3) To insure ductile welds in sheets thicker than ¼ in., the welds must be made in an atmosphere of purified argon. There can be no trace of atmospheric gases in the argon.

(4) The corrosion resistance properties of titanium are so good that the welds can be expected to outlast the parent sheet under conditions of corrosion action.

As the welding properties of titanium are in many respects similar to those of zirconium, the procedures outlined here for the welding of zirconium should apply almost equally to the welding of titanium.

A standard type of inert-arc electrode holder designed to carry up to 300 amp was used throughout extensive experiments. Argon of standard welding quality was used for all welds; it was described as not less than 99.80 percent pure, but the purity was not checked.

Apart from one or two special cases,

the welds were made on zirconium sheets of 0.030 in. and 0.060 in. thickness. Both sizes were welded with simple butt joints; the 0.030 in. sheet without filler rod and without edge preparation apart from insuring straight edges. In the case of the thicker sheets, the edges were chamfered to 45 deg, and zirconium wire of 0.050 in. diameter was used as a filler rod. The latter was carefully cleaned before use by rubbing it with emery cloth to remove all traces of oxide film and drawing lubricant.

For the d-c welds, the electrode was coupled to the negative pole of the current supply (straight polarity). Welding with reverse polarity was impracticable as the tungsten electrode tended to melt. Welding currents were: 45 amp (0.030 in. sheet) and 55 amp (0.060 in. sheet). The open-circuit voltage was 60, falling to 25 v when the arm was struck. For a-c welds, the current was 55 amp for the 0.030 in. and 65 amp for the 0.060 in. sheet. In both cases, the open-circuit voltage was 100 volts.

A special jig was made to hold the sheets in position. Each sheet was clamped to a piece of $\frac{1}{4}$ in. steel plate so that the edges to be welded extended slightly beyond the plates. The width of the gap between steel plates controlled the extent of the heat-affected zone. The most satisfactory widths were $\frac{1}{4}$ in. for the 0.030 in. sheet and $\frac{3}{8}$ in. for the 0.060 in. section and thicker. A stream of argon was directed through the opening under the joint to protect the back of the weld.

To determine whether or not ductile welds could be made in heavier sections of zirconium, it was decided to try welding in a totally enclosed box. This measured 9 by 7 by 7 in. and was made of mild steel with a transparent acrylic cover. The electrode holder was fitted into the front of the box through a gas-tight seal of convoluted rubber. The filler rod passed through a small hole covered with sheet rubber held in position by a flange. Welds up to 4 in. long could be made inside this sealed box.

To prevent atmospheric contamination, the box was exhausted to a pressure of one mm of mercury, filled with argon and exhausted again to one mm pressure. During welding, a flow of argon was maintained to keep the electrode and shield cool. The argon flow

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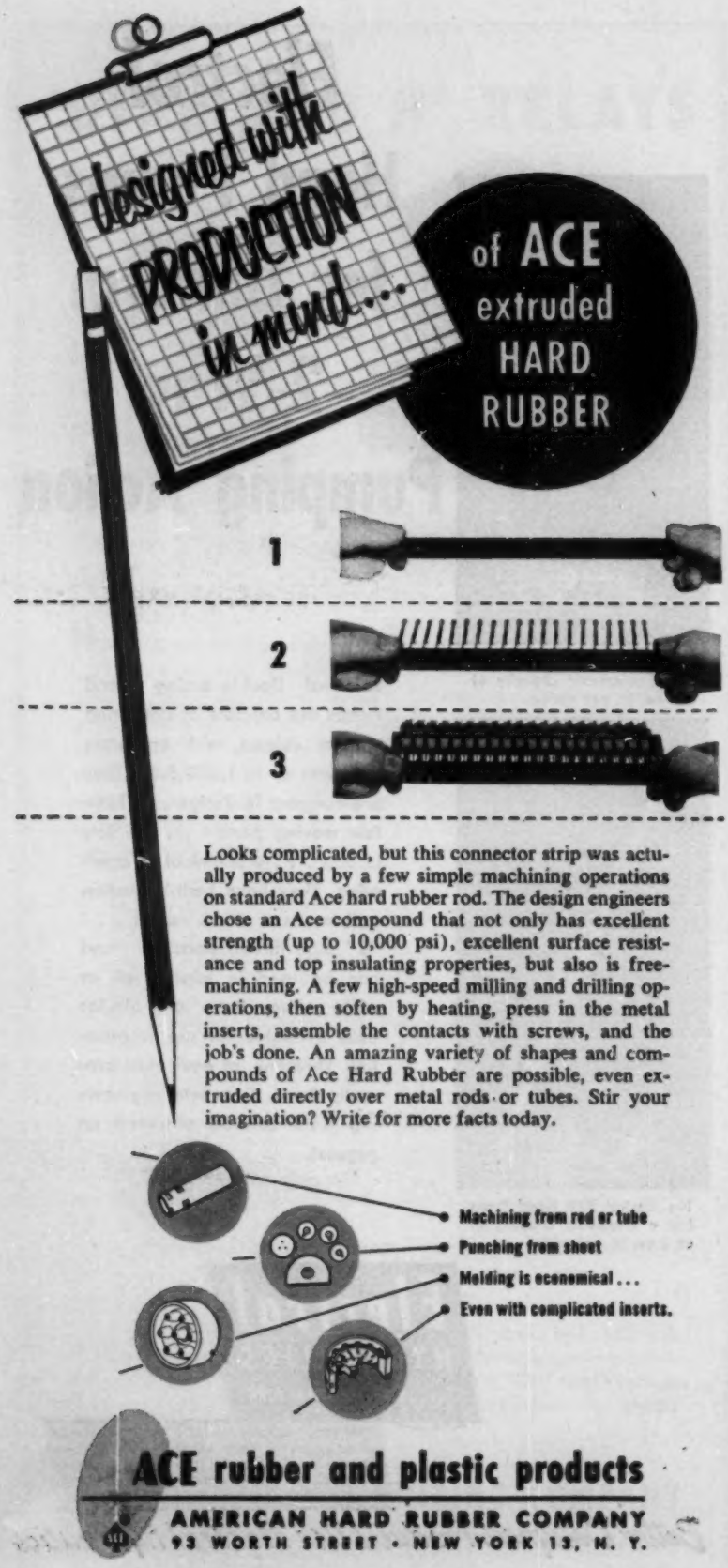
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also provided a positive pressure that prevented any possible infiltration of air.

This box resulted in the production of ductile welds (welds that were capable of immediate reduction by cold rolling), using either a-c or d-c, with and without filler rods.

Physical and Chemical Properties

Physical properties of the welds are given in Table I (alternating current) and Table II (direct current). All the tests were made on 0.030 in. sheets reduced to 0.015 in. either by grinding or rolling to remove inequalities in the thickness of the weld. All a-c welds were made in the box.

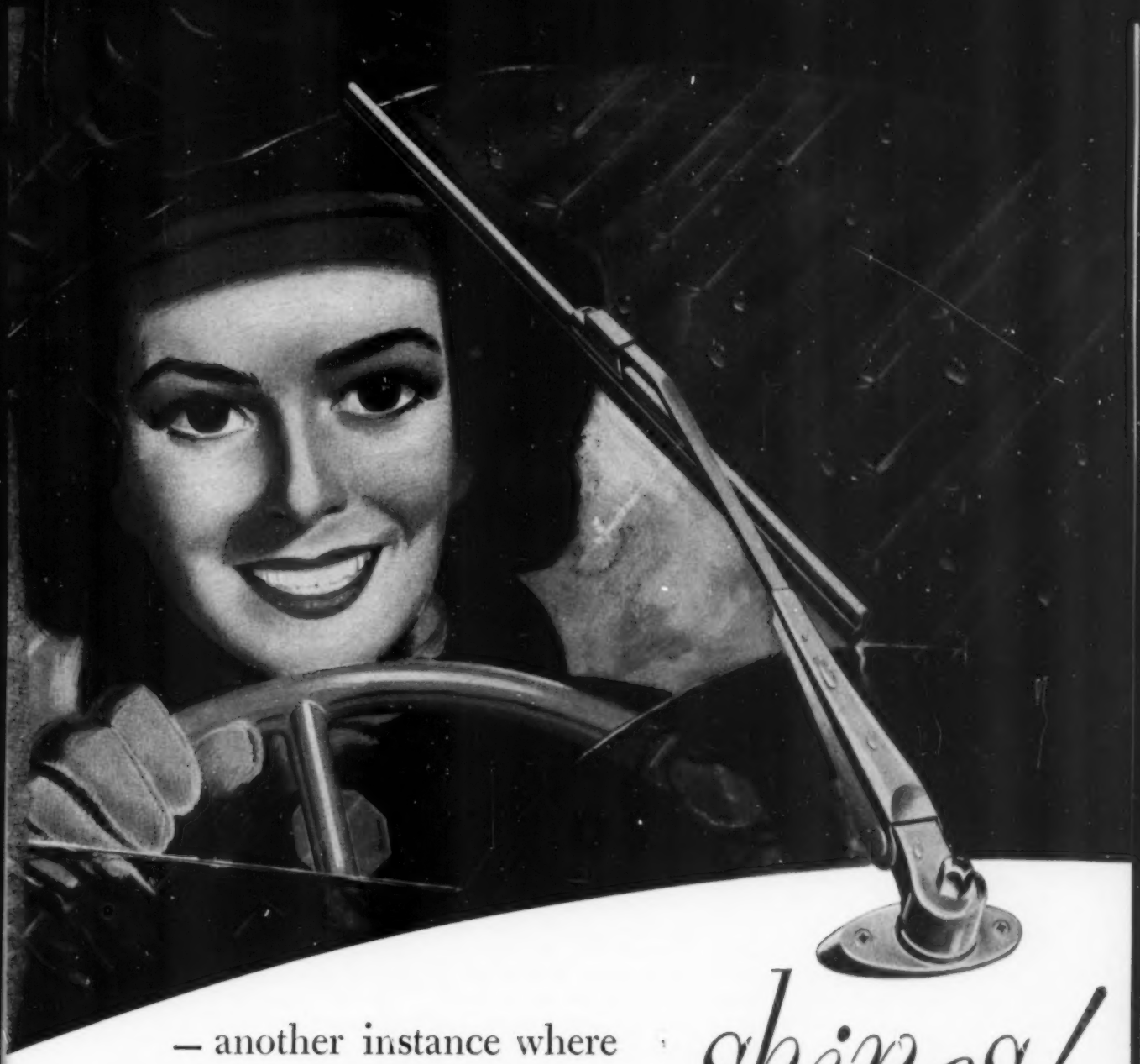
Bearing in mind the difference in the mechanical properties of the original sheet, these figures indicate that

Table I—Tensile Tests on Zirconium Sheet Welded by A-C

Description	Ult. Tensile Strength, psi	Elonga-tion, percent	Area Red'n, percent
Welded:			
Unannealed.....	64,600	14.0	25.0
Annealed.....	66,600	Not measured	
Annealed and rolled to 0.015 in., unannealed..	89,400	3.5	5.5
Unwelded:			
Unannealed.....	83,000	7.0	19.0
Annealed.....	50,600	10.0	34.0

Table II—Tensile Tests on Zirconium Sheet Welded by D-C

Description	Ult. Tensile Strength, psi	Elong., percent	Area Red'n, percent
Welded in air:			
Unannealed.....	91,200	4	8
Annealed.....	86,200	10	21
Annealed, rolled to 0.015 in., unannealed...	121,400	4	6
Annealed, rolled to 0.015 in., annealed.....	91,400	15	26
Welded in box:			
Unannealed.....	85,200	4	19
Annealed.....	87,200	8	18
Annealed, rolled to 0.015 in., unannealed...	120,400	3	11
Annealed, rolled to 0.015 in., annealed.....	86,600	12	14
Unwelded:			
Unannealed.....	105,000	4	12
Annealed.....	76,000	4	18



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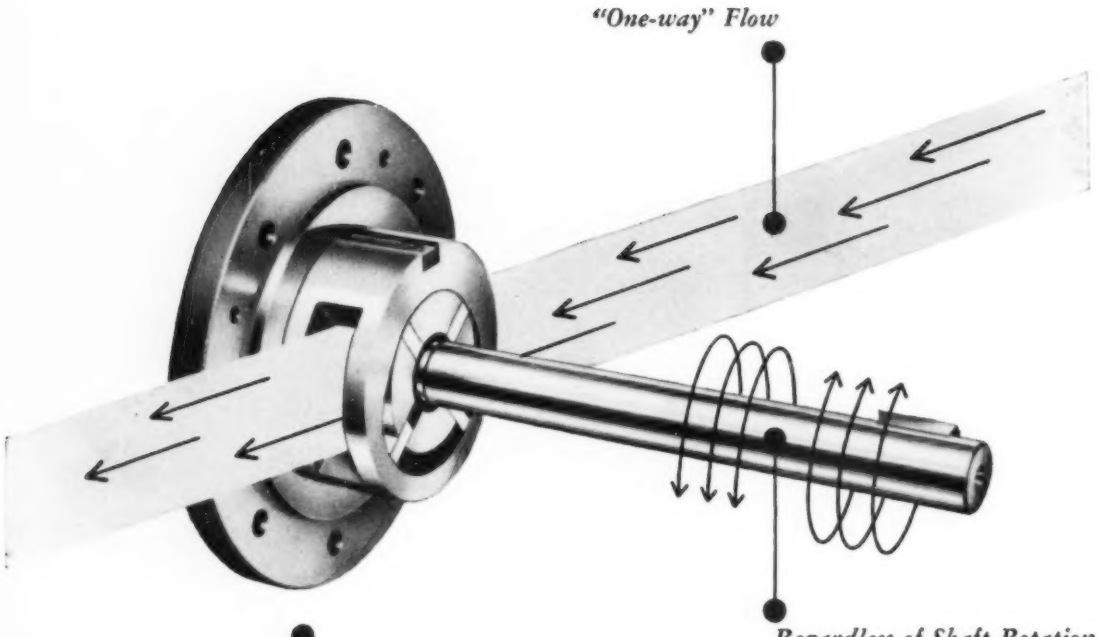

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the type of current has no significant effect on the mechanical properties of welds made on thin zirconium sheet, whether the welds are made in the box or with the unmodified electrode holder. This applies only to thin sheet; thicker sections are embrittled when welded with the unmodified holder. The tensile strength figures for the annealed and unannealed welds are similar because of the annealing that occurs during welding; the elongation and reduction in area figures are not available as some elongation occurred outside the gage length.

Corrosion-resistance tests were made by immersing the specimens for 24 hr in a bath at room temperature of concentrated hydrochloric acid containing one gram per liter of iron. The iron addition increases the corrosive power of the solution. To increase the corrosion conditions still further, the specimens were rotated in the bath at 300 rpm. All trace of oxide film was removed from the specimens with emery paper before immersion.

Investigation revealed that the actual welds and the adjacent heat-affected metal are more highly resistant to corrosion than the parent sheet; this improvement in the corrosion resistance of the welds has been displayed by all specimens tested to date. Examination under the microscope shows that the corrosive pits are larger and deeper on the non-heat-affected metal than on the welds.

Although it is possible to produce ductile welds on thin sheets of zirconium, purer argon than is commercially available at present is necessary to weld zirconium slab or plate without increasing the hardness above that of the original metal. Between the extremes of thin sheets and the slab or plate lies a range of thicknesses that is both important and useful. Ductile welds can be made in these thicknesses using commercial argon, but the conditions demand complete shielding of the arc.

Cold Extrusion Process

Abstracted from "Cold Extrusion Offers Production Economies" by Hans Schultz, *Machine Shop Magazine,* (London) April, 1953.

THE COLD EXTRUSION of steel offers many opportunities for achieving economies in design, material and production methods. The dimensional ac-

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Technical Service Data Sheet

Subject: HOW GRANODRAW PHOSPHATE COATING FACILITATES COLD EXTRUSION OF STEEL

INTRODUCTION

By phosphate coating steel, prior to cold working it, extrusion, drawing, and other forming operations are greatly improved. In fact, it is the protective zinc phosphate coating that makes for the successful cold deformation of steel.

The tremendous pressures that most forming operations require produce extremely high frictional contact between die and metal. Without a protective coating, excessive galling (welding) of dies, breakage of tools, and unduly short die life will result. The combination of a non-metallic crystalline phosphate coating with an adsorbed lubricating film, possesses a low coefficient of friction while maintaining its stability under extremely high deforming pressures. This combination, therefore, greatly minimizes the aforementioned tool difficulties.

THE COLD EXTRUSION OF GENERATOR FRAMES

Cold extrusion is now being used advantageously in the manufacture of high production generator frames. This operation is facilitated by careful preparation and proper coating of the frame blank which is made from SAE 1010 open hearth plate steel.

After wheelabrating to remove the scale, the blank is rolled up and then fed automatically through a six stage dip wheel type washing machine which cleans the surface and applies the coating. The frame is then fed into an extrusion press where the wall thickness is increased on one end and reduced 47.5 percent on the other end. This operation produces concentric frames of uniform thickness and correct dimensions.

The Granodraw coating produces the proper surface to receive the lubricant by furnishing an extremely adherent film with the proper crystal size and continuity of coating required to insure maximum adsorbsion and tenacity by the lubricant. The lubricant, Montgomery DF 1101, is a combination of titre alkali soaps and resins. It is a powder which when dissolved in water and redeposited on the phosphate coated work piece, produces the necessary surface for subsequent operations. This film is dry and considerably less hydroscopic than similar coatings of the soap type. The concentrations of both the Granodraw and DF 1101 are maintained by simple chemical analysis.

PROTECTIVE COATING SEQUENCE

Stage	Operation	Chemical	Time	Temperature
1	Load and unload			
2	Cleaning	Tri-sodium phosphate and soda ash	1 Min.	180° F
3	Water rinse		1 Min.	180° F
4	Zinc phosphate coating	"Granodraw"*	4½ Min.	165° F to 180° F
5	Water rinse		2 Min.	180° F
6	Lubricating	H.A. Montgomery lubricant DF 1101	4½ Min.	190° F

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curacy and surface refinement obtained in cold extruding frequently makes machining unnecessary.

In addition to the low and high carbon steels, alloy and stainless steels containing nickel, chromium, manganese and molybdenum can be cold extruded. The force required for extrusion is increased by the presence of carbon, manganese, silicon and molybdenum, either together or singly.

Molybdenum in a nickel-chromium steel appears to have a detrimental effect. Increased carbon or manganese contents give increases in strength, but the ductility with manganese is less than with carbon. Chromium behaves in a similar manner to manganese.

The limits of drawing, as opposed to those of extrusion, are obvious. In drawing, the work is under tension and the tensile strength of the steel governs the amount of reduction. In cold extrusion, the metal is under compression, therefore, theoretically, the tensile strength is not relevant. The plasticity of the metal is such that reductions in cross section of 85 percent have been obtained in a single press operation.

Cold extrusion of steel, however, is limited by tool strength, friction, and press capacity.

There are two cold extrusion techniques; backward, and forward. Backward extruding forces the metal to flow in a direction opposite to the punch or press ram travel as shown in Fig. 1. The degree of reduction and the relationship of punch diameter to the length of punch travel govern the limits of backward extrusion. The practical limit of the piercing punch

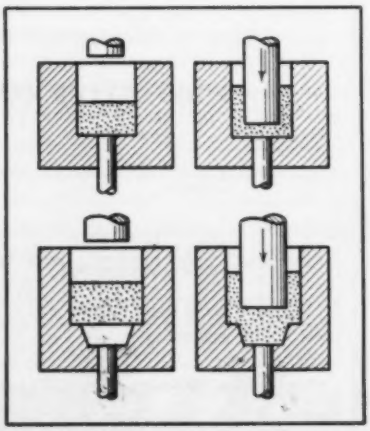

FIG. 1—Backward extrusion operations for cold working steel.

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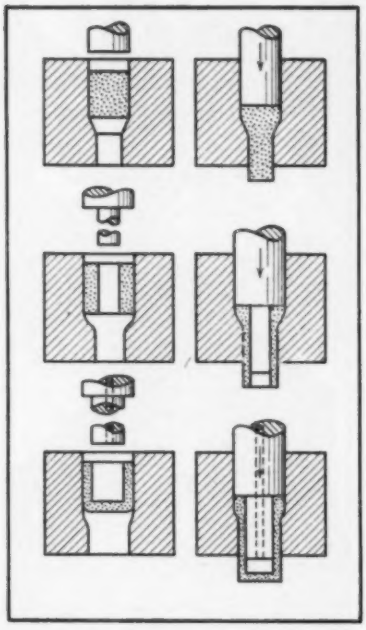

FIG. 2—Three methods used in forward cold extrusion of steel.

is three times its diameter. This ratio, however, can be increased by one-third by using guide bushings to reduce the column action of the punch. To reduce the impact on the punch and to facilitate steel flow, the punch pilot is usually designed with a 3 to 5 deg taper.

In forward extrusion, the metal flow is in the same direction as the punch travel as shown in Fig. 2. In forward extrusion, extreme reductions in cross-sectional area can be produced in one operation.

When forming shells, the forward extrusion process is best applied when the initial cup diameter is larger than 1 in. because of the high unit stress induced in the die. Since a high percentage of power is absorbed in overcoming friction, the length of shell to be extruded in a single operation is usually limited to five or six times the diameter.

The cold extrusion process requires about twice as much power as drawing because of the non-uniform stresses caused by the angle of the extrusion die and the greater friction area in the die. As a general rule, however, one extrusion operation replaces two drawing operations.

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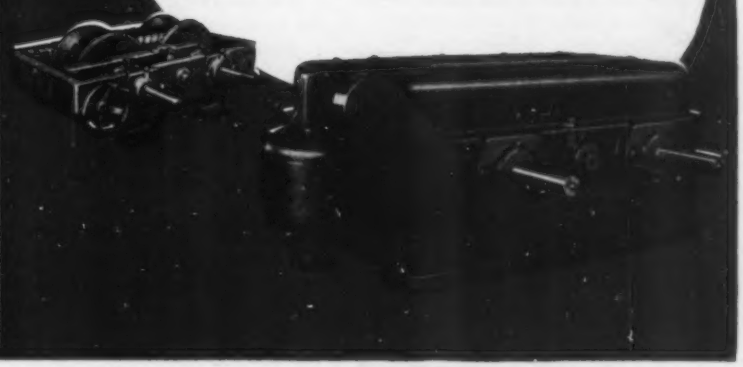

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cold extrusion process can be attributed to the use of a metal phosphate coating. This coating in itself gives a much lower coefficient of friction. When this coating acts as a "host" for a compatible lubricant, the coefficient is lowered still further. Together they form a film strong enough to withstand the compressive forces imposed on the film when the steel flows in the extrusion die.

Mechanical presses are preferred for the cold extrusion of steel, since the downward motion of the punch is continuous until it bottoms. With hydraulic presses, the punch tends to fall free until it makes contact with the work when there is a pause until sufficient pressure is built up to continue the downward stroke.

Extrusion pressures of 100 tons per sq in. have been encountered when forward extruding low carbon steel, while pressures of 175 tons per sq in. have been obtained when backward extruding.

Synthetic Rubber Packings For High Temperature Application

Abstracted from "Limitations of Synthetic Rubber Packings for High Temperature Application" by E. L. Carlotta, Mgr. of Rubber Research & Development and E. M. Hobein, Supr., Rubber Laboratory, The Parker Appliance Co., Cleveland, Ohio. Presented at SAE National Aeronautic Meeting, April 20-24, 1953.

PRESENT-DAY HYDRAULIC and pneumatic systems for military and civilian aircraft stress the need for high temperature sealing compounds. Many studies have been made of the static and dynamic aging of rubber at excessive temperatures and yet there are few facts for which contradictory evidence can not be found.

The question often arises concerning the maximum temperature for which it is possible to use a given rubber compound. To adequtaely answer this question, it is necessary to examine the individual application and assess the result which aging will have on the effectiveness of the rubber in the application. As an example, consider the hardening of rubber on exposure to dry heat. A 70 durometer Buna N rubber may be used at 350 F, but in relatively short time it will harden to 90 or 95 durometer. Will this hardening affect its useability? If it is being

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used as a vibration dampener, the answer is "yes", and such a temperature exposure must be considered critical. However, if the material is being used as a flange seal or piston ring the temperature may not be critical, especially if it has been anticipated and the designs adapted for it.

The problem is then twofold. After the best possible rubber has been obtained for a given application, the design engineer must take into account the inevitable changes which it will undergo. There are several general rules which should be followed.

First consideration should be the relationship of fatigue or breakdown to the initial deformation. A rubber component should be designed to place it under the least possible initial stress. Also, ample room must be provided for the swell experienced when rubber is exposed to certain oils or fuels.

The second rule is to anticipate other physical changes as a result of service conditions. It cannot be overemphasized that a change in physical properties of the rubber part should be anticipated. The design should have provisions to minimize the effect of these changes.

Supplying adequate lubrication wherever rubber is exposed to relative motion might seem elementary. This rule is often violated, however, with the result that the frictional heat is developed.

In addition consideration should be given to the relative incompressibility of rubber at higher temperatures, and the contribution of excessive deformation without lateral restraint to the formation and growth of flex cracks. Thus, if too much dimensional freedom is allowed to a compressed O-ring in the plane normal to the stress, bulging will occur, leading to cracks. Not even the most optimistic rubber chemist would advocate the use of presently available rubber compounds at high loads for extended periods of time over 450 F. However, the range between 300 and 450 F is borderline and it is in this range that the application of rubber in an assessory is most critical. If the rubber is being used in a pneumatic application without lubrication, the top limit will in most cases be 325 to 350 Fahrenheit.

Since the maximum temperature for which it is possible to use most hydraulic and lubricating oils is within

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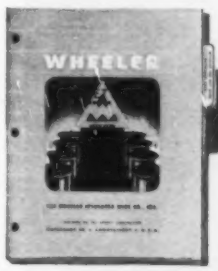

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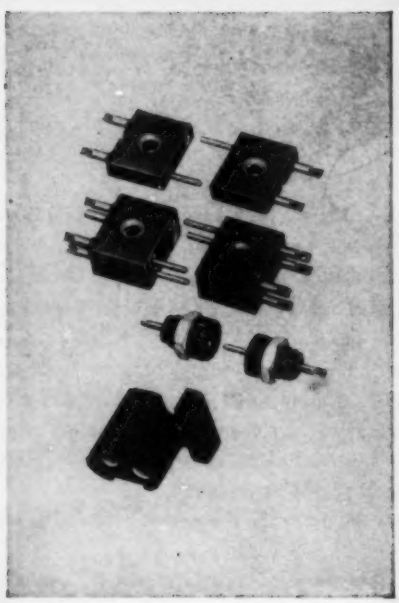

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this range, the problems with rubber at high temperature have not in most cases been insoluble. Of the applications which have not functioned properly with rubber the great majority utilized newer oils which are particularly severe on all elastomers.

Each type of rubber and each compound will respond at different rates and to different extent for any given temperature and time system. Presently available synthetic rubber compounds for use at elevated temperatures have top service temperatures which range up to about 525 F. This group is based on the following elastomers with the individual advantages and limitations noted:

I. Acrylonitrile Synthetic Rubber (Buna-N). This is one of the most useful of the seal molding rubber bases. It has excellent resistance to petroleum oils and synthetic base lubricants and can be used with hydraulic fluids at temperatures up to about 350 F. These compounds have low permanent set, superior characteristics as to tear and tensile strength, sunlight and ozone resistance, and can be compounded to function effectively at base temperatures of minus 75 F or lower.

II. Silicone Elastromers. Basically silicones are synthetic combination of organic and inorganic substances possessing the best properties of each. They are valuable for one or more of these four basic properties:

1. Resistance to Temperature Extremes. Temperatures as high as 525 F have little effect on the physical and electrical properties. Low compression set at high temperatures plus high thermal conductivity are also important.

2. Release from Sticking. Release readily from sticky materials over wide temperature range because of the inert surface of the material. Compounds are non-corrosive.

3. Inertness. Resist many aircraft hydraulic fluids and lubricating oils and are chemically stable at temperatures exceeding 600 Fahrenheit.

4. Unusual Surface Properties. Have excellent weather resistance and superior aging properties compared to most other synthetic elastomers.

III. Fluoro-Elastomers. This group is comprised of such materials as Teflon, Kel-F, and the like and are important for their virtual chemical inertness and resistance to temperatures up to about

400 F. Fluoro-elastomers have rather poor elastomeric characteristics compared to synthetic rubber, and when formulated into compounds for improved flexibility, most of the elastomers present an added problem in that the plasticizer used reduces strength, chemical resistance, and heat resistance.

IV. Acrylic Rubber. Acrylic rubber vulcanizes because of the chemically saturated nature, show excellent heat and hot oil resistance up to 350 F. Above that temperature, they show accelerated loss of weight in air, a negative swell in oils, and become hard and brittle in shorter periods of time. This group is made up of such rubbers as HyCar Polyacrylic, Lactoprene, and Acrylon BA-12 and EA-5.

Their tendency to take a permanent set or to cold flow at only moderate temperatures is a limiting factor and resistance to most hydraulic oils is unsatisfactory. The acrylic rubbers are recommended in applications where advantage can be taken of their special properties such as O rings, oil seals, coolant seals, gaskets, packaging, diaphragms, and grommets.

Design of Bonded Rubber-to-Metal Joints

Abstracted from "Bonding Methods for Adhering Rubber to Metal" by J. H. Gerstenmaier, Molded and Extruded Goods Plant, Goodyear Tire and Rubber Co. Paper presented at 21st ASTE Annual Meeting.

THE CONDITION OF THE METAL SURFACE has a direct effect on adhesion values. The data shown in Table I are a tabulation of a laboratory test of bond strengths obtained with various types of surfaces of the same steel with the same rubber and metal preparation. Specimens were subjected to shear loading, and the control grit

Table I—Relative Adhesion Values for Various Surface Conditions

Surface Condition of Steel	Percent
Control grit blasted surface.....	100
Finely polished surface.....	147
Hammered finish.....	97
Small longitudinal corrugations..	86
Large longitudinal corrugations..	70
Small transverse corrugations....	63
Large transverse corrugations....	59

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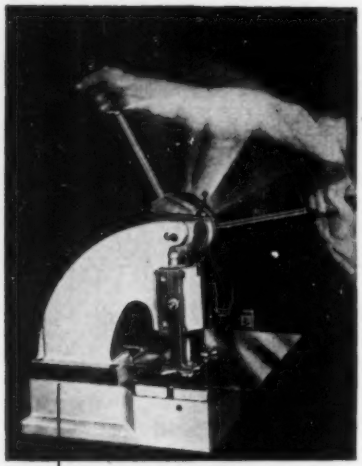

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blasted surface is listed as the 100 percent value.

These results show conclusively that corrugations used to increase adhesion area not only fail to improve bond strengths, but actually decrease them. The best type of adhesion surface is finely polished and continuous, but such refinement is generally unnecessary. Finishes produced by smooth rolling, drawing, machining and grinding are satisfactory, provided that slag inclusions, pits, folds, seams and burrs are avoided. Smooth cast or gouged surfaces are acceptable also if no protruding sprues, flash fins, pits, porosity and other surface defects are present. Generally, it is necessary to sand blast or pickle adhesion surfaces to remove rust or scale.

If the part is a functional part which in operation is loaded in shear or tension, the part must be designed with a factor of safety for the bond. While bond strengths of 250 psi can be maintained consistently in the design of mild steel parts, it is desirable to incorporate adequate adhesion area so that under maximum dynamic load the bond is not stressed in excess of 125 psi. This gives a safety factor of two to one under the worst conditions. Space limitations at times prevent this but, wherever possible, the bond stress should be kept low. Tension mountings are infrequently used because the characteristics of rubber in tension are poor. A small nick in a rubber fiber tends to progress and cause the entire mounting to fail. When materials other than mild steel are used, the difference in adhesion values should be taken into consideration.

On shear and compression mountings, liberal fillets should be provided at the edge junction points, Fig. 1. Mountings *a* and *b*, lacking adequate edge radii, are poorly designed from viewpoint of edge effects. In *c* and *d*,

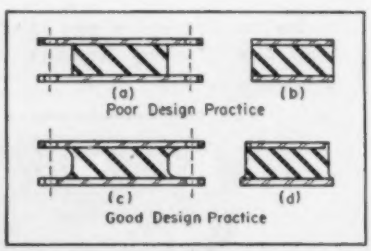

FIG. 1—Designs *a* and *b* without edge radii are redesigned as *c* and *d* wherein the fillets are adequate.

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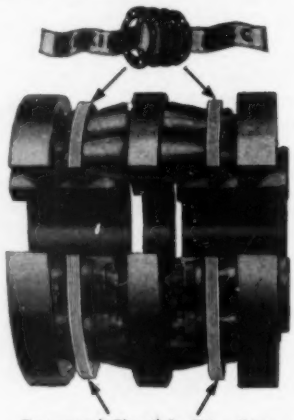

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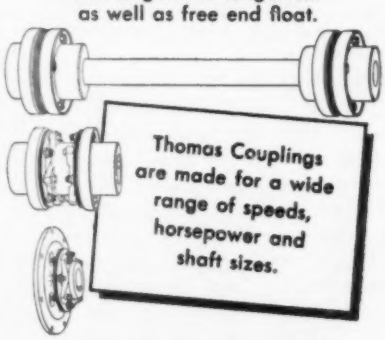

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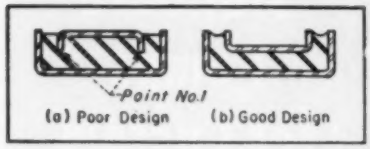

FIG. 2—Design *a* would build up stress concentrations at arrow points. Redesign *b* avoids this complication.

the same mountings are redesigned with fillets to relieve edge stress. Mount *d* is preferred for production rather than *c* since the part without undercut would be easier and more economical to mold. Strictly from a performance standpoint, however, *c* would be preferred.

Edge radii are especially important on shear mountings. Test results show that mounts with edge radii may run as much as 50 percent longer on fatigue tests than those without.

Stress concentrations indicated by arrows in Fig. 2 (a) should be avoided whenever possible. The high stress concentration at Point No. 1, may cause failure of the mount along the adhesion surface even though the bond is good. A design to accomplish the same purpose without objectionable stress concentration appears in Fig. 2(b).

Rubber-to-metal adhesion values of 250 psi can be expected under normal manufacturing conditions. Adhesion values of 500 to 1,000 psi (direct-tension button test) can be obtained but these figures should not be used as expected bond strengths when designing for production. In fact, laboratory testing specifications should be established on basis of the strip test rather than on straight pull test.

Production Soldering

Abstracted from "Soldering on a Production Basis" by Lester F. Spencer, Chief Metallurgist, Landers Frary & Clark, *Welding Engineer*, June, 1953

SOLDERING as a production technique is used for sealing when the mechanical strength of the joint depends upon a prior process such as spot welding, riveting or lock seaming. It is also used by itself as a joining medium if little mechanical strength is required, and neither loading nor stress concentrations will be present during service.

With suitable modifications, solder can be applied to nearly all types of

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metals and alloys. Soft solders, used at temperatures below 800 F, are made of lead, tin, bismuth, antimony and other ingredients including arsenic cadmium, zinc and silver.

The most frequently used alloys contain only lead and tin. Ease of manipulation is often the basis for selection, which explains the common usage of the 40 tin-60 lead and the 50 tin-50 lead mixtures. Both have a wide plastic range between the solidus and the liquidus.

Few solders contain over 62.0 tin. No advantage is gained, and the cost of the alloy becomes progressively higher. There is one exception: an alloy containing 95.0 tin and 5.0 antimony, which has a melting range of 450-464 F. Its high electrical conductivity renders it especially suitable for electrical applications. Another type used for electrical applications at higher temperatures contains 1.5 silver, about 1.0 tin and the balance lead. It melts at 589 Fahrenheit.

Strength values, either in shear or tension, can be obtained on the solder itself or on the soldered joint. In the former case, the tensile strength of either lead or tin is about 2,000 psi; when the two elements are alloyed, this strength value increases rapidly. A maximum strength of 6,500 to 6,800 psi is realized at the eutectic composition.

The tensile strength of the soldered joint will be affected by the adhering properties of the specific material being joined. The tin-lead alloys will soften in the course of time and suffer loss of joint strength. This losss, which may amount to as much as 25%, reaches its maximum after about a year. The strength of the joint then remains constant.

Joints for soft soldering are similar to those in brazing; the lap or butt joint and modifications of each are widely used. Thorough cleaning prior to soft soldering its necessary. Mechanical methods of cleaning include abrasive wheels, filing, scratching or shaving. Chemical methods involve dipping into (or brushing on) a compound that dissolves oxides or other foreign materials from the surfaces.

The use of a flux is a prerequisite, the type depending on the alloy and the material being joined. Corrosive fluxes such as zinc chloride, ammonium chloride, hydrochloric acid and

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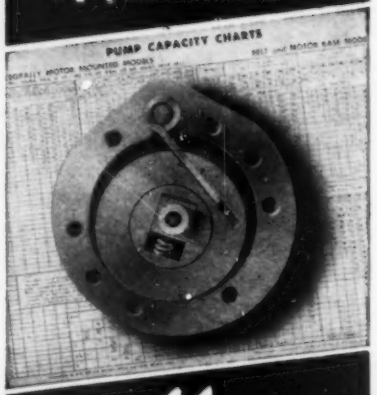

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phosphoric acid will usually remove thin oxide films that form after cleaning. However, the excess flux must be cleaned off directly after soldering has been completed.

Zinc chloride is one of the most common compounds used as a soldering flux. Since it has a melting point of 500 F, it is not used with solders containing more than 30.0 tin. A lower-melting flux (about 356 F) can be obtained by mixing three parts of zinc chloride with one part of ammonium chloride and dissolving the mixture in water.

Diluted hydrochloric acid at a concentration of 1:1 with water is used to some extent as a flux. One use is in soft soldering the stainless steels or other materials having tightly adhering oxides. Aluminum and metals with highly resistant oxides require a still stronger flux. Such a flux can be made by adding hydrofluoric acid to hydrochloric acid.

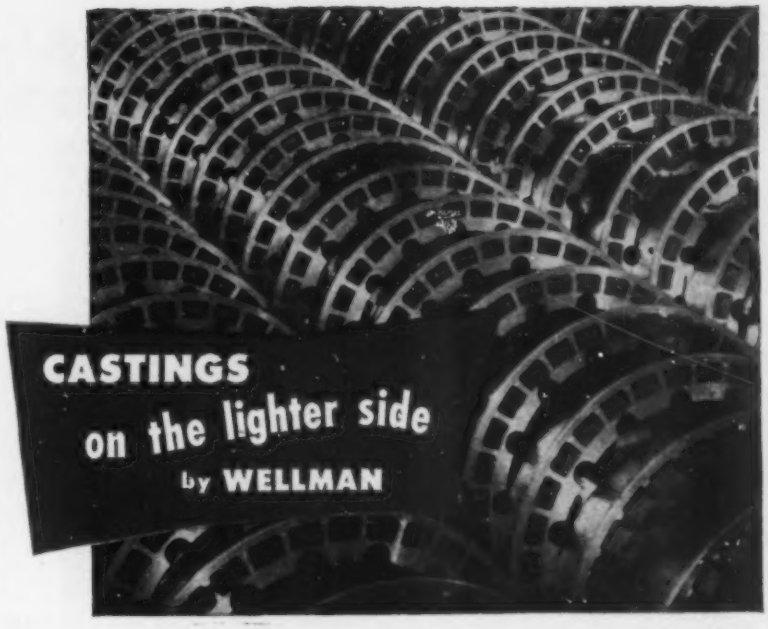
The resin-type fluxes are non-corrosive but must be handled carefully and not overheated, or the fluxing properties will be destroyed.

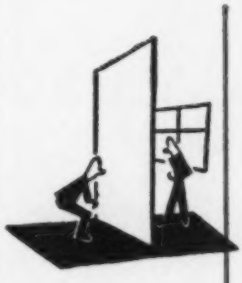
In hand soldering, the proper choice of both iron and diameter of the rod solder is important. If the bar of solder is too thick, too much solder is usually applied, and the iron loses heat so rapidly that the soldering job may not be perfect.

The soldering bit should have good thermal capacity and good thermal conductivity; the preferred combination being found in electrolytic copper. In addition, the bit should be as large as possible, consistent with the operation.

Dip soldering is usually used where high production or line assembly of soldered joints is needed. Ordinarily, dip soldering is applied where clearances are small and large fillets are not desired. Cleaning is followed by the application of flux and then by dipping into the molten solder. Excessive delay between the fluxing and the dipping operations should be avoided and accurate control of the temperature of the dip solder bath is required to minimize the dross that may form.

Induction heating is now invading the field of soft soldering. Where this method has been applied, success has been experienced in producing strong joints at a high production rate





If you're thinking along the lighter side about the whole subject of magnesium and aluminum castings, think about Wellman as a source.

As the contractor, standing in one room of his new inexpensive house, said to a friend in the next room, "You can *hear* me, but you can't *see* me? Them's some walls, ain't they!" . . .

"Them's some walls" on a Wellman lightweight magnesium casting, too, thin in appearance but tough enough for our biggest jet bomber landing wheels . . . and easy to machine!

Let us show you how our four complete plants and almost a half century of experience can help you. Write for our new catalog No. 53.

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Well-Made WOOD AND METAL PATTERNS

THE WELLMAN BRONZE & ALUMINUM CO.
Dept. 16, 12800 Shaker Boulevard Cleveland 20, Ohio

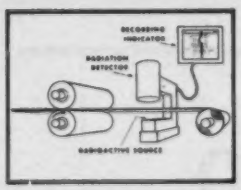
SHOCK AND VIBRATION NEWS

"Gives the customer THE ULTIMATE IN VIBRATION PROTECTION for his instrument"

Photo courtesy INDUSTRIAL NUCLEONICS CORP.

Type C-2000 Barrymounts for heavy industrial service. Ask for Catalog 304-B.

The AccuRay Beta Gage — a sturdy industrial instrument for continuous production gaging of plastics, textiles, paper, rubber, and metals — is specifically designed to resist vibration. So why does Industrial Nucleonics Corporation use Barrymounts?



"We use Barry shock mounts solely as a vibration isolator to protect the instrument from externally caused vibrations. We would not consider marketing the instrument without the added safeguard of the mounts. We feel that the use of mounts is indicative of the thoroughness of design of our instrument, and that it gives the customer the ultimate in protection for his instrument."

Is protection against shock and vibration vital to the performance and the life of your equipment — or is this protection a "plus" dictated by thoroughness of design? In any case, Barrymounts give you the assurance that you have the ultimate in vibration protection. Ask the nearest Barry representative for his recommendations.

THE BARRY CORP.

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with economical use of solder.

It is more difficult to solder stainless than copper, brass or plain-carbon steel. Rigid precleaning procedures must be used, and great care taken in the application of both flux and solder. Prior tinning often aids in the production of a good soldered joint in both type 302 and 430 stainless steels.

Muriatic (hydrochloric) acid at a 1:1 dilution is often used to clean the joint areas. The choice of flux may include (a) muriatic acid saturated with zinc chloride; (b) muriatic acid saturated with zinc chloride to which about 10 percent acetic acid has been added; (c) a 10 to 20 percent solution of orthophosphoric acid in water; and (d) a mixture of muriatic acid and zinc chloride, to which is added about 25 percent more hydrochloric acid than in (a) and 2 to 5 percent hydrofluoric acid. The fluxing agent (d) is said to be excellent for stainless steels that contain molybdenum, titanium or columbium. The tin-lead solders are applicable to the joining of this class of material.

The soldering of the aluminum-base alloys is difficult because of the oxide film present on the surface. This film is not readily touched by a soldering flux, so that mechanical removal is necessary. For soldering aluminum, tin-base alloys are used containing from 50 to 85 tin, 15 to 50 zinc and from 0 to 15 aluminum.

Friction-type solders are used without flux. Heat is applied to the metal, and the solder is then rubbed on the aluminum surface. When the proper temperature has been reached, the solder will melt and tinning will take place.

Flux removal is vital to the success of aluminum soldering. A procedure recommended is to use a two percent sulphuric acid solution followed by a one percent nitric acid solution and then a rinse in warm water. Small parts may be dipped, but larger parts can have the solutions brushed on in the order stated. In either case, thorough rinsing is required.

The high thermal conductivity of aluminum specifies a high heat input to raise the joint members to soldering temperature, which is between 550 and 700 Fahrenheit.

When soldered joints in aluminum

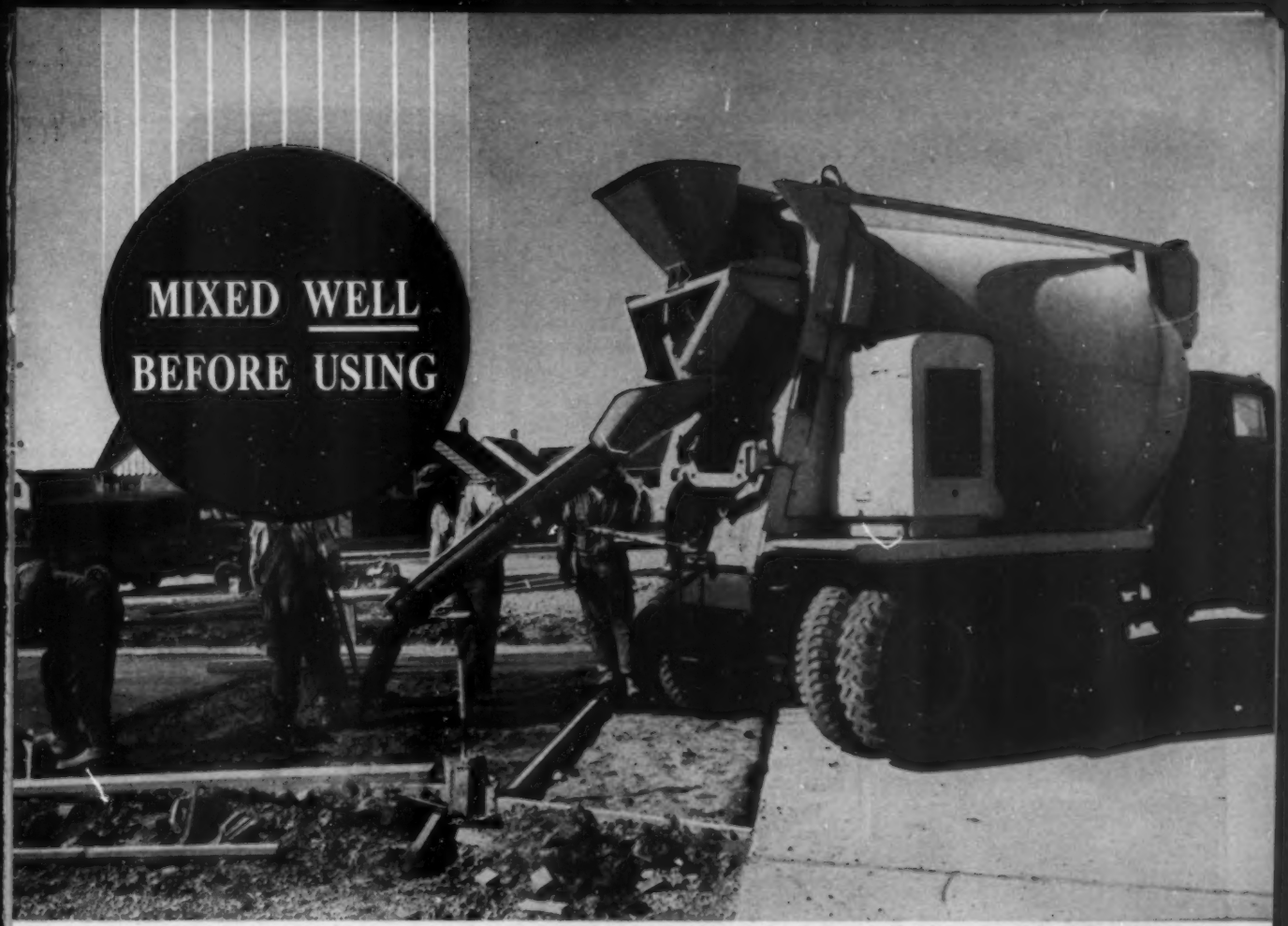
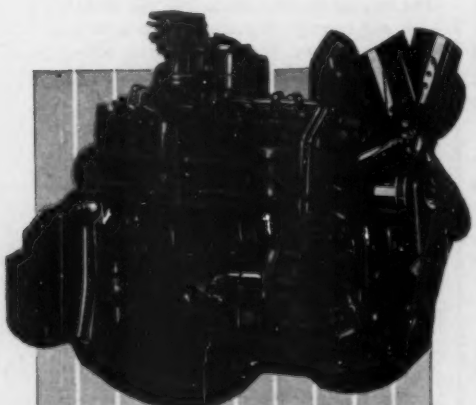


Photo courtesy Chain Belt Company, Milwaukee, Wisconsin

Chrysler Power and gýrol Fluid Coupling help remove work and jerk from transit-mixing . . .



Chrysler Industrial Power pumps water, digs ditches, harvests grain, cuts lumber and . . . mixes cement. And very well too. Construction people claim the mixing action of this seven-yard truck mixer is extremely efficient and its charging and discharging speeds excellent, even with coarse mix.

From its position at the rear of the Rex Roto-Mixer, the 230 cubic inch displacement Model 6 Chrysler Industrial Engine supplies ample power for the mixing mechanism. At the same time, Chrysler gýrol Fluid Coupling protects mixer, engine, clutch and transmission from the life-shortening wear imposed by the combination of heavy payloads, sudden starts and stops. Prevents stalling too.

This is simply Chrysler Industrial Power doing a specialized job *better* because the engine was selected and equipped to meet the requirements of this particular job. The manufacturer—like every other—chose from a great number of Chrysler options. Among them: gasoline, natural gas or liquid-propane burning carburetors, 3, 4 or 5 speed transmission, standard or gear-driven front ends (with magneto or hydraulic pump drive), twelve or twenty-four volt electrical systems.

Chrysler offers ten power-proved industrial engines for your consideration. They are not expensive because Chrysler production-line methods allow us to mass-produce custom-built engines and sell them at mass-production prices. See the nearest Chrysler Industrial Engine Dealer for complete details, or write: ***Dept. 47, Industrial Engine Division, Chrysler Corporation, Trenton, Michigan.***

CHRYSLER
Industrial Engines

HORSEPOWER WITH A PEDIGREE

are exposed to humid and marine atmospheres, long laps or scarf joints are recommended. Joints subjected to salt spray can be cathodically protected by attaching strips of zinc or cadmium close to the joint. In humid atmosphere or if water contacts the joint, it is good practice to protect the joint by a coating of moisture-proof lacquer or paint.

Soft soldering of the high-nickel alloys is limited to applications where neither corrosion resistance nor mechanical strength is of importance. Soldering is suitable only up to thicknesses of 0.062 in. since in the heavier gages other methods of joining are more satisfactory. The "cut acid" fluxes commonly used for the copper alloys are satisfactory for the soldering of Monel metal and pure nickel.

A stronger flux is usually required for the soldering of Inconel because of the refractory chromium oxide that tends to form on the surface of the sheet.

The soldering of magnesium-base alloys is usually confined to the filling of imperfections in either castings or sheets where a smooth surface is required. The alloy usually used is either a combination of 60.0 cadmium, 30.0 zinc and 10.0 tin, which melts at 315 F, or a combination of 90.0 cadmium and 10.0 zinc, which melts at 500 F. Neither of these filler metals requires flux.

For soldering iron and steel, ammonium chloride (sal-ammoniac) is the preferred flux. For zinc and galvanized iron, raw hydrochloric acid is used. Difficulties in the soft soldering of steel can often be avoided by providing a thin copper coating on the joint area, by applying blue vitriol (copper sulphate) which a solder will wet satisfactorily.

Pewter may be soldered with a material that has the same composition as the base metal. The finest pewter consists of tin hardened with antimony, copper, and bismuth; while cheaper grades have large percentages of lead. When in doubt or if the composition is unknown, solder with either a pure tin or an alloy of lead, bismuth and tin.

Because pewter has a low melting point, exert considerable care when soldering it. Clean the metal by abrasion, and use a resin flux or turpentine during soldering.

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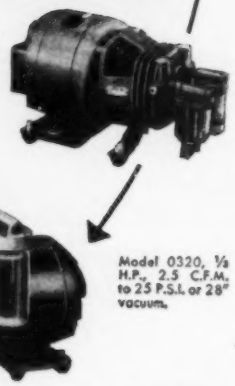
two handy packages-- these GAST rotary-vane INTEGRAL-MOTOR AIR PUMPS



Standard Model 0210, ⅙ H.P., 1.3 C.F.M. to 25 P.S.I. or 27" vacuum. Oil-less Model, to 10 P.S.I. or 15" vacuum.

Model 0320, ⅓ H.P., 2.5 C.F.M. to 25 P.S.I. or 28" vacuum.

You can solve many an air-pump requirement—vacuum or pressure—with one of these "handy packages." For Gast *integral-motor* Air Pumps are widely used as original equipment by engineers who require smooth, dependable performance in a compact, space-saving unit.

Pump rotor is mounted on motor shaft, and motor frame provides a rigid mounting for pump housing.

The smaller Model 0210, a highly popular unit, supplies vacuum for engraver's printing frames, feeding devices, laboratory use, etc., in either lubricated or oil-less models.

For vacuum to 28" in low volume applications, Model 0320 is used for production line testing for leaks, for punch press feeding devices, etc. There are scores of uses for these "packaged" integral-motor pumps.

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GAST MANUFACTURING CORP., 139 Hinkley St., Benton Harbor, Mich.

Sans, Souci

Ad Libbing by the Editor

Naturally I get a lot of mail from various readers and some of it is extremely interesting. Much of it is confidential. A short while ago I received a very interesting letter that was stimulated by the editorial which had appeared in February *Product Engineering* under the title, "Why Can't We Do It Too". The message of the editorial was to the effect that we would profit more by learning how the Germans developed their engineers rather than by confiscating some of their machines or products. The editorial brought forth a letter from a German who is now in this country. Here is what he says, I having paraphrased the letter in order to condense it and to hide any possibility of revealing the writer's identity:

I was born a German, was in love with the art of designing and became an instrument engineer. By 1918 I had risen to the rank of chief engineer but in 1937 I was forced to leave Germany in order to save the life of my Jewish wife. When I left my employer my development department had grown to 350 people with an annual budget of three million Marks. When I left the job my boss gave me a wonderful recommendation.

I had worked extremely hard to get to the position of chief engineer. I had to be an expert in production as well as design. I had to be able to keep books, understand advertising and selling and on top of this I personally wrote a one-thousand page technical book and was active in the development of a new type of magazine in the technical field. My earnings were more than $25,000 per year in dollars or $50,000 per year in purchasing power.

When I left Germany I naturally selected the United States as the country in which I would like to live and continue my career. So here I am and I want to answer some of the questions which you posed in your editorial."

I think one of the reasons for the great progress and the high rank of engineering in Germany is that the

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sheets, rods, tape, tubing,
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The United States Gasket Company was one of the pioneers in the fabrication of Fluorocarbon Plastics.
• Profit from this broad experience, greater "Know-how" and their completely modern specialized facilities for low-cost, close tolerance production of Teflon* and Kel-F† Stock and custom-molded or machined parts.
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*du Pont Trademark †M. M. Kellogg Trademark
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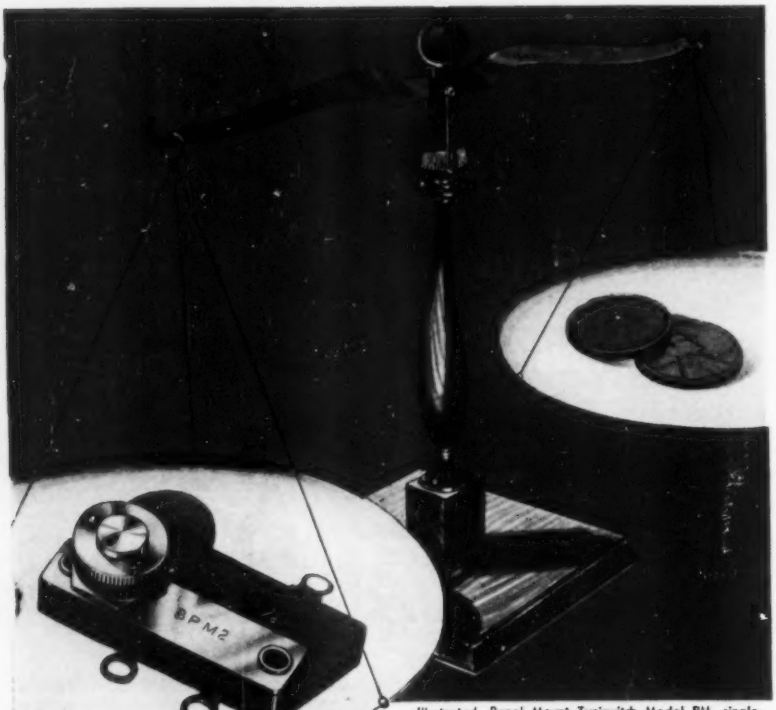

Illustrated: Panel Mount Tyniswitch Model PM, single-pole, double-throw, 15A., 125V. A.C.; 7½A, 250V. A.C. Overall length 1⅝".

The only miniature snap switch

where size and high rating come to terms with cost

Repeat: *where size and high rating come to terms with cost.* Consider this in terms of engineering that seeks to increase product efficiency while holding costs at a minimum. Then base your snap switch specifications on the following facts.

TYNISWITCH is a low cost, compact snap-action unit based on simplified construction principles. It permits high-load switching in a minimum amount of space. It eliminates costly, non-functional bulk in new or redesigned products. No other model or make — of comparable size and rating — can match its high-standard performance. Its action is flawlessly smooth and dependable. Moreover, it has been conclusively proven by approved laboratory tests that TYNISWITCH is completely reliable . . . for over millions of cycles!

Investigate these and many other TYNISWITCH advantages today. New models can be developed economically to fit your specifications — or you can select conventional circuit arrangements from a variety of standard units. Write for details. TYNISWITCH Division, The Sessions Clock Company, 103 East Main Street, Forestville, Connecticut.

average good German engineer really loves his job and has the ambition to do the best he can and better than his competing company even if his design results in a product that might be slightly more expensive. As an example, a small instrument could be made to sell at one-fourth the price but had four times as large an error. In spite of the fact that the customers liked the cheaper instruments my company discontinued their manufacture because it was considered that the reputation of the company as a manufacturer of precision instruments was at stake. I think such an attitude would be utterly impossible in the United States where sales and profits regardless of quality standards are considered many times more important than technical progress.

I do not think that there is much important difference between German and American colleges and technical schools. A good creative engineer is born and not made by education, although it of course develops his talents. I was in Russia in 1933 and it seemed to me that their method of educating engineers was more on the practical level. But I always maintain that a good engineer cannot be spoiled by the worst college. He will learn anyhow.

One important point, and an extremely important point, is that engineers in Germany have much greater authority than they have here in the United States. In most German companies the management consists of college-trained engineers rather than salesmen who have had no technical training.

You are perfectly right when you say that the attitude in America is that America alone has all the greatness. Before 1913 it was considered that nothing made in America was good. Everything had to be imported from Europe, especially Germany. Now the pendulum has swung to the other side. If a product does not originate in America it is considered to be not good. Also here in America there seems to be the conception that technical or engineering brains can be measured in terms of quarts or gallons. Here is an editorial that appeared in one of your technical journals:

'GERMAN ENGINEERS imported at the close of the war to work on rockets are now offering their services to universities and to

industry. It seems, says our Washington informant, that they've been drained of useful data but the army still wishes to keep them on tap. The idea is not working so well. American engineers apparently feel that they will have enough competition in the years immediately ahead without importing it.'

Can the brain of a genius ever be drained?

Just to indicate that America doesn't have everything that is biggest, I am sending you herewith a copy of an advertisement that appeared in Deutsche Maschinenbau A.G. with a picture of the biggest 'floating crane in the world', with a height of more than 345 feet and capable of lifting 350 tons. Four of these huge cranes were built in 1937 by the Demag Company of Germany. This compares with the total lifting capacity of 250 tons and a total height of 137 feet of the Monarch, the largest commercial floating crane in America, owned and operated by Merritt-Chapman & Scott.

It seems to me that most of the wonderful products in the technical field developed in the United States have been developed with the tax payers' money and not with company money. In contrast, the Siemens Company invested more than three million Marks between World War I and World War II to develop Beryllium.

When I came to America I hoped to be able to use my talents in my profession but was denied this opportunity because I was (1942) an enemy alien. I did invent and patent some measuring instruments, some of which are being manufactured by small companies for the government. Although I applied for the patents before I became a government employee I was told that I cannot claim royalties because I am a government employee.

Ironically, the hundreds of German engineers who came here after the war are in minor jobs or teaching. American engineers do not like to work under German engineers."

Very truly yours,
Anonymous

Many readers will not agree with some of the statements in this letter but probably most will agree that in sum total the writer presented basic facts.

Another interesting letter that I got from a reader was one from H. L. Ratchford, Engineering Specialist, Sylvania Electric Products Inc. at Hunt-

Product of
Northern Electric Co.
Chicago, Illinois

THIS Northern Electric Sheet is "just the thing" to take along on that vacation, to the mountains, the lake or the seashore. You're assured of restful slumber, undisturbed by sharp dips in the temperature (so usual) while on vacation . . . and wake up rested, relaxed and ready to go. The reliability of the electric sheet temperature control and protective thermostats are largely dependent upon its Chace Thermostatic Bimetal element.

The automatic temperature control supplies the warmth you desire all through the night. When the circuit is closed, current passing through the thermostat is supplied to the sheet heating elements which maintain the temperature setting regardless of changing room temperatures. Like a night watchman, always alert but rarely called upon for action, the protective thermostats are an additional safety device. In the event of any kind of failure, the current flow is automatically controlled by these self adjusting thermostats.

Chace Thermostatic Bimetal is precision manufactured in 29 types, in strips, coils, random long lengths and welded or brazed sub-assemblies. Before proceeding with the design of your new actuating device, consult our Application Engineers, recognized authorities on temperature responsive devices—or write today for our 32-page booklet "Successful Applications of Chace Thermostatic Bimetal," containing condensed engineering data.

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Solve Sludge Problem with Nicholson's

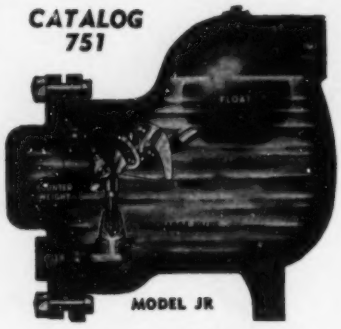
New AIR TRAPS

With the introduction of an exclusive new oil-eliminating feature, Nicholson air traps now enable you to enjoy the advantages of the positive intermittent action of a float-operated air trap without the common problem of oil congealing on the mechanism and impeding or stopping its action. Other features of Nicholson air traps:

1) No air-wasting vent, such as is in all inverted bucket traps.
2) Positive water seal of valve.
3) Large orifice keeps valve clean, preventing blow-through.

Three types; pressures to 1500 lbs. For details send for . . . .

CATALOG 751



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HEAVY-DUTY *Air-Cooled* ENGINE POWER

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More than 500 manufacturers of engine-powered machines of all kinds, utilizing power within a 3 to 36 horsepower range, specify WISCONSIN Heavy-Duty Air-Cooled Engines as "original equipment" on their machines.

They base their selections of engines on such factors as heavy-duty construction, low-cost operation and maintenance, Air-Cooling that provides trouble-free service in all locations, easy starting, and readily available replacement parts when needed, through a reliable source.

Wisconsin Motor Corporation is the world's largest manufacturer of Heavy-Duty Air-Cooled Engines, from 3 to 36 horsepower, in 4-cycle single cylinder, 2- and 4-cylinder types. Here is dependable power to *fit the machine* and *fit the work* for which the machine is designed.

4-cycle single cylinder 3 to 9 hp.

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V-type 4-cylinder 15 to 36 hp.

WISCONSIN MOTOR CORPORATION

World's Largest Builders of Heavy-Duty Air-Cooled Engines

MILWAUKEE 46, WISCONSIN

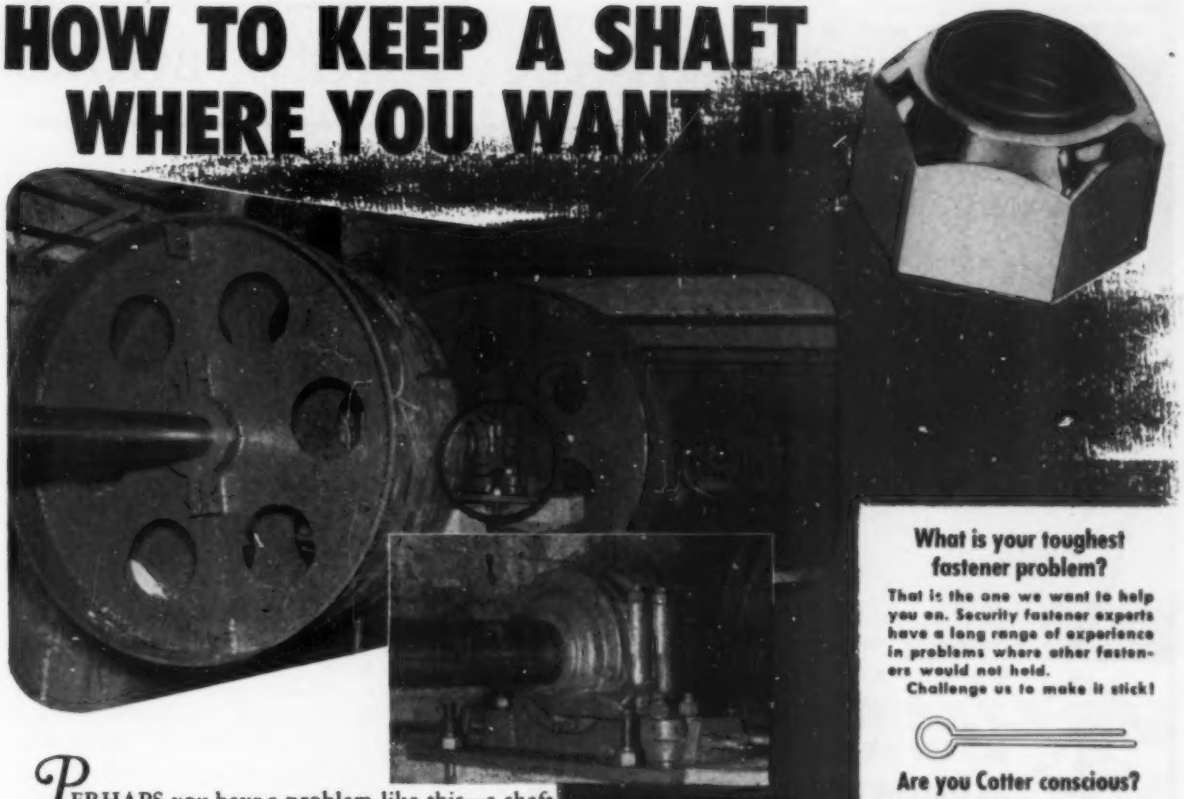
ington, West Virginia. It is a comment on the Sans, Souci which appeared in February in which I told the story of the three pictures that depicted the exit of the steam locomotive. Mr. Ratchford sent me a copy of a cartoon which I am republishing herewith. The mechanic is trying to get a 0.001 inch adjustment using a Stillson wrench. The cartoon was inspired in the mind of a young engineer while he was looking at a mechanic trying to adjust a small nut with a hammer and a punch in order to get a delicate adjustment. As Mr. Ratchford pointed out, the cartoon could well serve as an inspiration for an editorial. —*G. F. N.*

FCC Curbs Heating Equipment

Starting the first of July, the Federal Communications Commission will crack down on owners of induction heating, dielectric sealing, and electric welding equipments that are emitting radio frequency energy, interfering with broadcast or television wave lengths. Plants using offending apparatus will receive notification to remedy the condition or face government prosecution for violation of FCC's code.

Government requirements for proper shielding of radiation-prone equipment are not new; enforcement is. In the past, FCC has granted several time extensions to industry so that all violations could be corrected. In public notice 85968, the government agency warned that they would not grant any extensions past June 30, 1953.

HOW TO KEEP A SHAFT WHERE YOU WANT IT



PERHAPS you have a problem like this—a shaft bearings right off the pedestal!

Keeping the line shafts from shaking the pillar block hold was a problem for the Publishers Paper Company of Oregon City until they found out about "Security". Now the shafts stay "put".

Not only do Security Locknuts keep the line shafts in place but they to cut down service time and reduce wear wherever vibration gives trou in the mill. Security Locknuts can stop *your* vibration trouble, too.

There is no other locknut like Security and no other locknut will do what a Security will do. Security Locknuts are self-locking in any positio They do not require bolt tension to keep them tight. They stay whe you wrench them, even in the face of vibration that *destroys* the bol

A Security Nut can be removed and replaced any number of times without materially loosing the torque or locking power and without injury to the bolt. This means easy maintenance for your customer's customer. Installation is fast—nothing to line up—no extra parts—nothing to shear!

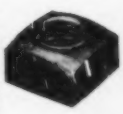
Authoritative tests have proved conclusively the gripping power of Security Locknuts. We would like to have you see the reports on these tests. Security Locknuts are made in ⅜" to 3" bolt sizes. *Fill in the coupon for more details.*

SECURITY LOCKNUT CORPORATION

North Ave. at 15th Ave. Melrose Park, Illinois

STUDLOC
The Studloc provides a positive lock in counterbores and housings or it can be keyed into work to serve as a simple locknut.

CAPLOC
A cap nut that locks with the grip of the Security Locknut. It combines locking power and protection for bolt ends where protection is needed.



RAIL-LOC
A square locknut for switches, crossings, bridges. The only reusable locknut that can be hot-dipped galvanized for corrosive locations such as alkali, etc. Sizes ¾" to 1⅜".

Security

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What is your toughest fastener problem?

That is the one we want to help you on. Security fastener experts have a long range of experience in problems where other fasteners would not hold.

Challenge us to make it stick!

Are you Cotter conscious?

There may be places where cotters are the only solution but cotters are expensive to install. Security Locknuts eliminate the adjustment of expensive castellated nuts, drilling and weakening bolts and setting cotters. You install Security just like an ordinary nut.

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LOW IN COST
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★ No deterioration in storage
★ Capacities up to 65 amperes
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NEW BOOKS

High-speed Engines

P. M. HELDT, 5½ x 8½ *in.* 472 *pp. Published by P. M. Heldt, Nyack 9, N. Y.* $7.

In this seventh edition, the text has been revised and brought up to date and new illustrations have been added. In particular, the chapters with the greatest amount of new material are those dealing with injection pumps and governors, two-stroke engines, railroad engines, supercharging, and methods of starting.

The content of the book is as follows:

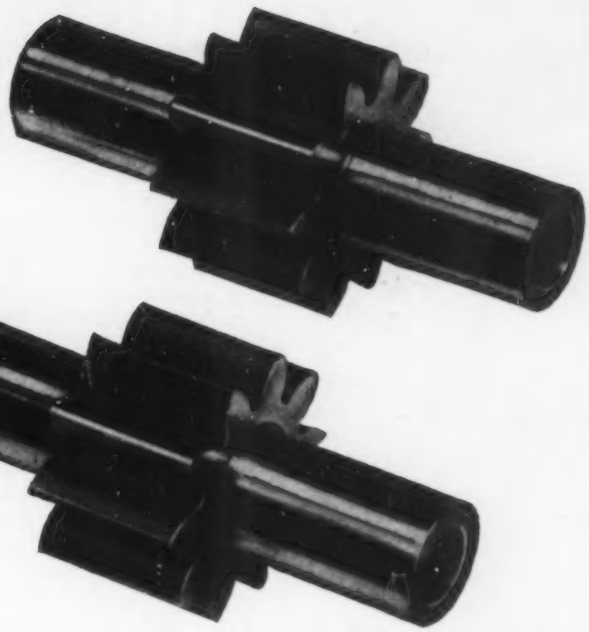
Chapter I, Nature of the engine and its fields of application. II, Thermodynamic and other characteristics. III, Combustion phenomena. IV, Fuels for Diesel Engines. V, Fuel injectors and sprays. VI, Injection pumps, their principles and characteristics. VII, Modern injection pumps and governors. VIII, Precombustion-Chamber engines. IX, Direct-Injection engines. X, Turbulence-Chamber engines. XI, Auxiliary-Chamber engines. XII, Two-Stroke engines. XIII, Railroad engines. XIV, Supercharging. XV, Some details of engine design. XVI, Methods of starting Diesel engines. XVII, Lubrication. XVIII, Operation and maintenance. XIX, Gas Turbines.

Signal, Noise and Resolution in Nuclear Counter Amplifiers

A. B. GILLESPIE, *Harwell (England) Atomic Energy Research Establishment.* D. W. FRY, *Harwell AERE, General editor.* 152 *pp,* 5½ x 8 *in. Published by McGraw-Hill Book Company,* 330 *West 42nd St., New York* 36, *N. Y.* $4.50.

The backbone of experiments in nuclear physics and atomic energy in the counting device. Because you can't see—and often can't get near—nuclear reactions, you have to rely on instruments to report what is taking place.

This text contains, in one volume, the first comprehensive account of the factors involved in using nuclear counters and their accompanying cir-



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This SIMPLICITY OF DESIGN is important for these reasons!

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Add *Pesco Simplicity of Design* to Pesco's exclusive, patented "Pressure Loading" principle, which results in volumetric efficiencies up to 97% and torque efficiencies up to 90%, and you have two important reasons why so many industrial and aircraft manufacturers have standardized on Pesco pumps.

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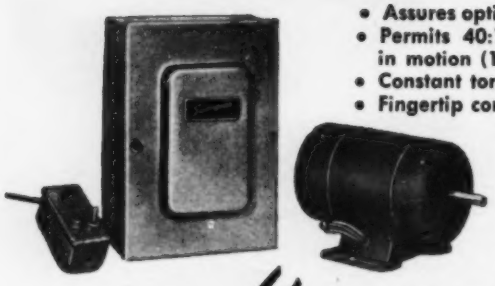

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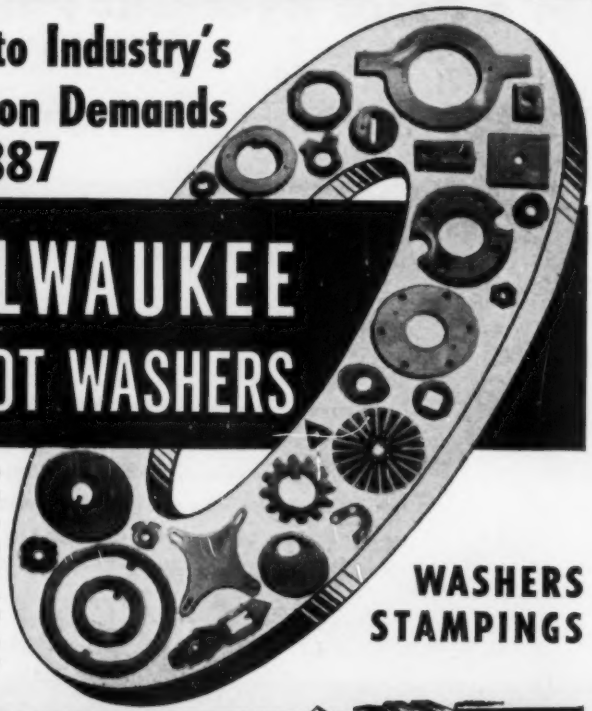

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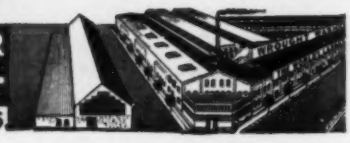


cuits. It is a collection of monographs based on the Author's own experiments at England's "Oak Ridge" establishment. Some material appears in print for the first time.

Much of the book is concerned with a discussion of noise in election tubes. Ordinary communications equipment can tolerate a certain amount of static, but noise becomes a major factor in nuclear studies, particularly when working with materials that are not too active.

Final emphasis is placed on proportional and scintillation counters.

Written on a high level for research men or engineers seriously concerned with the development of atomic energy, the book requires a working knowledge of advanced calculus.

The book is the first in a new series which this publisher plans on applied modern physics and communications.

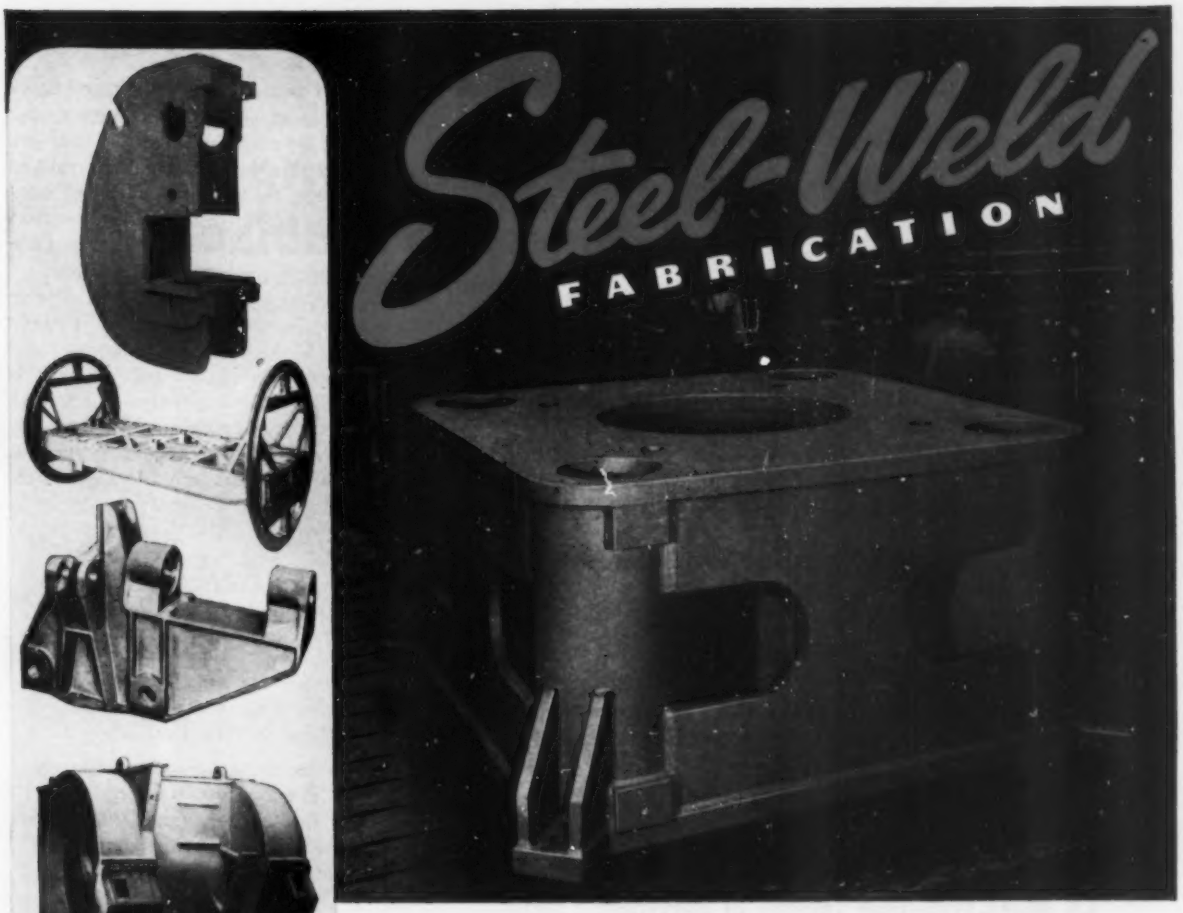
Theory of Plasticity For Engineers

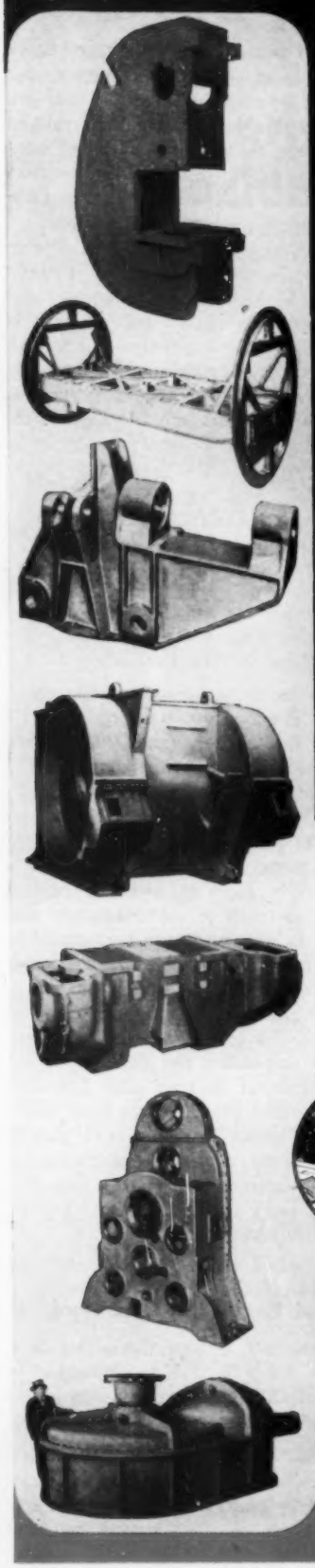
OSCAR HOFFMAN, *Prof., Dept. of Civil Engineering & Engineering Mechanics, Case Inst. of Tech. and* GEORGE SACHS, *Research Prof., Inst. of Industrial Research, Syracuse, Univ. 6 x 9 in., 276 pp. Published by the McGraw-Hill Book Co., 330 W. 42 St., New York 36, N. Y. $6.50.*

This text deals with that comparatively recent branch of mechanics which treats the behavior of ductile metals beyond the elastic range. Presented in readable and logically organized treatment, it not only introduces the fundamentals of the science, but also gives accounts of all major engineering applications of the theory of plasticity.

Comprehensively covering the subject, the book treats first the basic theories of post-elastic behavior, including state stress, strain, elastic behavior of metals, theories of strength, plastic stress-strain relationships, and experimental data. These discussions are presented in sufficient detail to facilitate a complete understanding of the engineering applications offered later. The applications used are drawn essentially from fields in which comparison of working solutions and experimental results obtained is possible.

After treatment of theory, classic examples of process which involve





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Illustrated above is a twenty-two ton Moving Cross-Head for a 2500 ton Press. This and other units illustrated at the left are typical of thousands of Steel-Weld Fabricated parts and assemblies produced and machined by Mahon for hundreds of manufacturers of heavy machines and equipment. If parts of your product could be redesigned and produced to better advantage through Steel-Weld Fabrication, or, if you require a limited number of large heavy pieces, in which pattern costs are a consideration, you can turn to Mahon with complete confidence . . . personnel and facilities are available within the Mahon plant to do the complete job from drawing board to finished machining. You will find in the Mahon organization a unique source with complete ultramodern fabricating, machining and handling facilities to cope with any type of work regardless of size or weight . . . a source where skillful designing and advanced fabricating technique are supplemented by craftsmanship which assures a smoother, finer appearing job embodying every advantage of Steel-Weld Fabrication. See Mahon's Insert in Sweet's Product Design File, or write for further information.

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How Beryllium Copper Springs keep foods fresher...longer

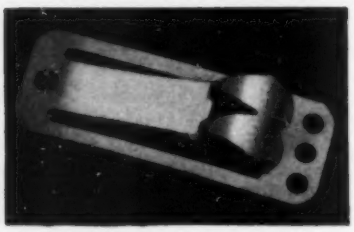
A BERYLLIUM COPPER SPRING is the "memory cell" of the defrosting mechanism of a leading household refrigerator. This small flat spring completely eliminates the necessity for remembering to defrost at the proper intervals. Thus, this beryllium copper spring functions in the defrosting timing cycle of the refrigerator — and through this increased efficiency, it helps keep foods fresher . . . longer.

The design engineers set rigid specifications for this defroster-actuating spring. They wanted, above all, maximum dependability and long life. The production department insisted on early and frequent deliveries after design details had been settled . . . and they wanted them in large quantities. And, naturally, the purchasing office demanded lower unit costs!

There's nothing too exceptional about these specifications. But there *is*, we believe, an unusual story in the manner in which they were exceeded—*on every count!*

I-S Micro-Processed Springs of Beryllium Copper

were chosen and are still being used for this installation because of their 4-way superiority:



(*1*) HIGHER DEGREE OF UNIFORMITY AND dependability than conventionally-made springs.

(*2*) I-S DESIGN ENGINEERS' SPECIALIZED experience in spring-making aided in redesigning for our exclusive "strip spring" technique which permits hardening in multiple fixtures to assure the uniform dimensional and elastic performance. This also resulted in substantial unit-cost reduction.

(*3*) THIS SAME I-S EXCLUSIVE STRIP DESIGN showed further savings in subsequent assembly-line operations—such as cleaning, inspection and attaching of the silver contacts and elimination of costly hand adjustments.

(*4*) ONLY I-S EXCLUSIVE TECHNIQUES, methods and patented equipment could have produced these far superior springs within the time limits set by the production department.

You have the identical basic problems—time and unit costs, plus product performance. We feel that this particular spring application clearly demonstrates two important Instrument Specialty features: *(1) our ability to produce a better spring, faster and usually at lower cost to you. (2) the specialized ability of our engineers to cooperate with your designers in meeting practically any exceptional problem that involves spring-making.*

It cost you nothing to compare methods and costs.

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234 C BERGEN BOULEVARD, LITTLE FALLS, NEW JERSEY
Telephone Little Falls 4-0280

For full information on I-S Micro-processed Springs, write today for your free copy of Catalog 7, for Electronic Components, ask for Catalog No. 7-A.

rather small plastic strains are offered as a next step of development, for these are most similar to elastic strains. After this presentation, there follows logically the step to problems of large plastic strain. In conclusion, the final section is devoted to important technological metal-forming processes.

Because the authors have already tested in their teaching of graduate courses their treatment, method, and sequence of study and the mathematical tools and notations here employed, their resulting work is not only scholarly, but practical, comprehensive, teachable, and adapted to engineering needs.

How to Control Production Costs

PHIL CARROLL, *Consulting Industrial Engineer.* 6 x 9 *in.*, 272 *pp. Published by the McGraw-Hill Book Co.*, 330 *W.* 42*nd St., New York* 36, *N. Y.* $5.

Both men in the management group and accounting will find this a practical explanation of costs, and a guide to keep production costs down while maintaining high quality.

The book shows how to get more accurate product costs and how to control them. A helpful new approach is taken in applying overhead expense (1) in terms of conversion time and (2) in accordance with rates caused by the different products in multiproduct industries.

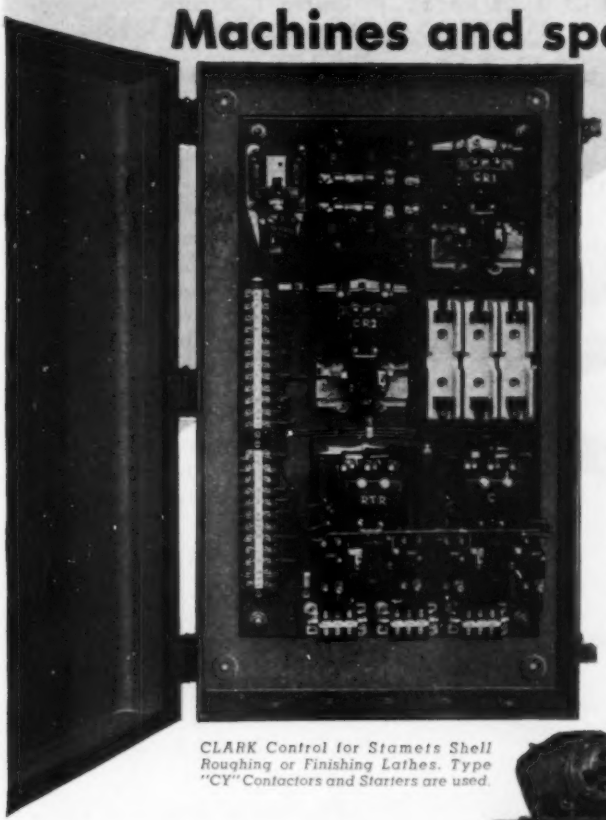
In showing step by step how to apply this control procedure, the author emphasizes five factors: the importance of accurate sales forecasts; controlling production to know deliveries, reduce inventory, and shorten the process cycle; saving excess finishes and tolerances with realistic engineering; using incentives; and reporting results promptly.

Tool Engineers' Data Book

GERHARD J. GRUEN, *Consulting Engineer,* 6 x 9 *in.*, 219 *pp. Published by Reinhold Publishing Corp.*, 330 *W.* 42 *St., New York* 36, *N. Y.* $5.50.

This is a compilation of the tables, formulas, constants and specifications used by practicing tool engineers and designers. A special effort has been made to cover all the latest develop-

CLARK TYPE "CY" STARTERS
efficiently control STAMETS Heavy-Duty Machines and speed shell production!



CLARK Control for Stamets Shell Roughing or Finishing Lathes. Type "CY" Contactors and Starters are used.

In several plants, Wm. K. Stamets No. 2R Shell Cut-Off machines, and Shell Lathes are producing 105 MM and 155 MM shells at a high rate.

Three types of machines, all with CLARK CONTROL, are used in each production line. A cut-off machine faces the solid end of the forging and cuts off the open end to the required length. The Roughing Lathe roughs out the shell, and the Finishing Lathe gives the shell its final contour and finish.

Depending on the size of the shells, and the optimum cutting speeds, the cut-off machines turn out 34 to 60 shells per hour.

While not completely automatic, the entire process is greatly simplified, loading and unloading, cutting off and turning of the shells is accomplished with a Foot Pedal, a "start" push button, and motion is stopped by a Limit Switch.

STAMETS No. 2R Shell Lathe.

Desirable cushioned stopping of the roughing spindle motor is accomplished by using current limiting resistance in the reverse plugging circuit. Smooth fast stopping, with no shock to the machine and no interference with production rate results.

Clark Type "CY" Starters and Relays controlling the Finishing Spindles provide completely satisfactory service.

Machine tool control problems are easily solved when CLARK TYPE "CY" equipment is used.

You'd better try **CLARK TYPE "CY"**

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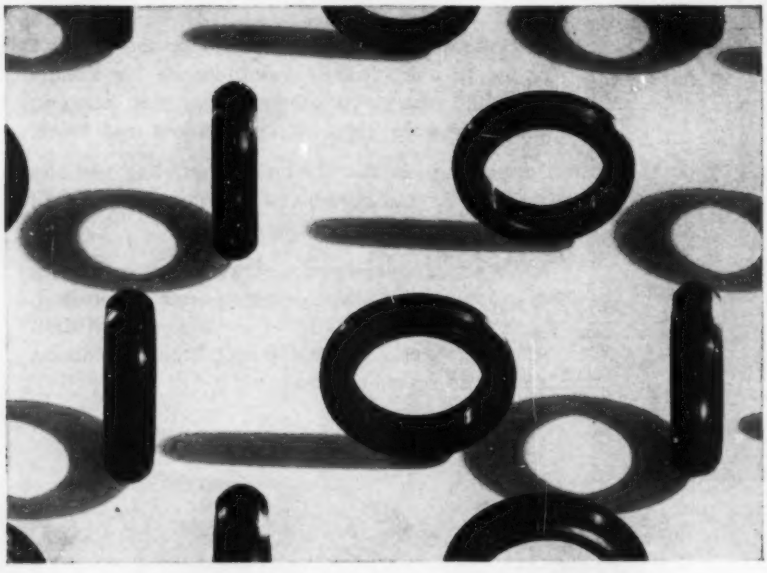
SARAN RUBBER GASKETS ARE SOLVENT RESISTANT

Organic compounds like carbon disulphide, ethyl alcohol, trichloroethylene, xylene have little effect on saran rubber



Saran rubber mechanical goods exhibit outstanding resistance to a wide range of organic solvents from alcohols to xylol. They are characterized by a low degree of swell and a low rate of permeation to most solvents and gases. Carbon bisulfide, chlorine, phosphorous trichloride vapors with HCl, toluene, and trichloroethylene are typical compounds that are resisted by saran rubber gaskets.

Saran rubber is readily molded on conventional rubber molding equipment into complicated shapes such as diaphragms, valve pads, heavy-duty gaskets, and stoppers. These saran rubber products have been used in many and varied gas and solvent resistance problems confronting equipment manufacturers today.

Specify saran rubber to your molder. We will be glad to assist him in the development and production of saran rubber mechanical goods for your specific requirements. For a free data booklet on saran rubber molded goods write to the **Saran Lined Pipe Company,** 2415 Burdette Avenue, Ferndale, Michigan.

RELATED PRODUCTS

Saran rubber tank linings • Saran lined steel pipe—corrosion-resistant pipe that gives long-term operation with minimum maintenance costs.

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you can depend on DOW PLASTICS DOW

ments, many of which have never before appeared in book form.

The material is presented as follows:

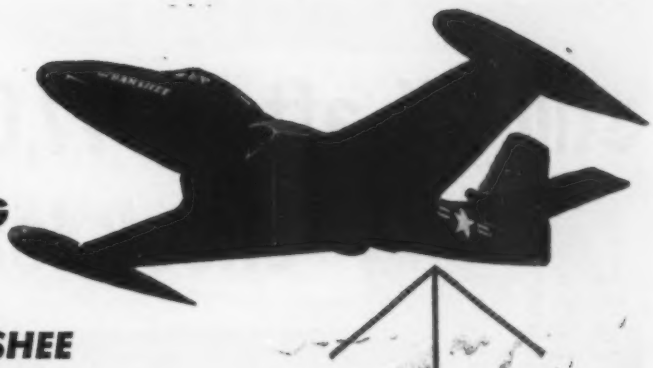
Chapter 1, Standard Specifications; Chapter 2, Physical Constants Of Metals and Alloys; Chapter 3, Chemical Properties Of Metals and Alloys; Chapter 4, Mechanical Properties Of Metals And Alloys; Chapter 5, General Properties Of Special Alloys; Chapter 6, General Properties Of Plastics; Chapter 7, Weights Of Metals And Alloys; Chapter 8, Heat Treatment Of Metals And Alloys; Chapter 9, Rapid Identification Of Metals And Alloys; Chapter 10, Rapid Identification Of Plastics; Chapter 11, Working Properties Of Metals And Alloys; Chapter 12, Operational Tables; Chapter 13, Standard Formulas; Chapter 14, Conversion Tables; Chapter 15, Mathematical Tables; Chapter 16, Definitions Of Metallurgical Terms.

Fluid Dynamics, Volume IV

Edited by M. H. MARTIN. *Editorial Committee:* R. V. CHURCHILL, ERIC REISSNER *and* A. H. TAUB. 186 *pp*, 7 x 10 *in. Published by the McGraw-Hill Book Co.,* 330 *W.* 42*nd St., New York* 36, *N. Y.* $7.

This volume consists of fourteen papers on Fluid Dynamics which were presented at the Fourth Symposium on Applied Mathematics, held at the University of Maryland, June 22-23, 1951. It contains subject matter which can be divided into four categories: Turbulence, Compressible Flow, Foundation, and Incompressible Flow. Included are significant contributions on the statistical theory of turbulence, papers on the mathematical theory of supersonic and transonic flow, and a treatment of shock waves and gravity waves. The subject of incompressible flow is represented by articles on propeller theory, numerical methods, viscous flow, and the method of singularities.

Specifically the following papers are included: *Some Aspects of the Statistical Theory of Turbulence* by S. Chandrasekhar; *A Critical Discussion of Similarity Concepts in Isotropic Turbulence* by C. C. Lin; *The Nonexistence of Transonic Potential Flow* by Adolf Busemann; *On Waves of*



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Nine of the electro-mechanical actuators on the McDonnell Banshee F2H-2 use Saginaw Recirculating ball-bearing screw and nut mechanisms. Installations include wing fold, main landing gear, landing gear doors, speed brakes and nose landing gear. Saginaw screws with rotary-to-linear force transmitted through rolling steel balls operate at more than 90% efficiency. This means that the torque —the rotary power equipment—is only a small fraction of that required for a thread-to-thread screw, thus resulting in important weight savings. Saginaw screws are efficient, accurate, reliable, compact, and low in weight-strength ratio. They can be effectively combined with electrical, hydraulic or pneumatic units and can be furnished for actuator applications in any size in a complete range of load and life requirements.

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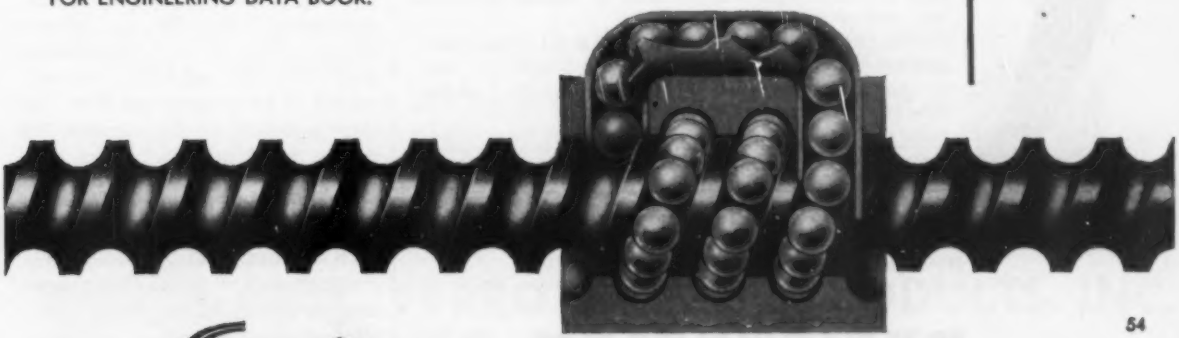

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Saginaw STEERING GEAR

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MANUFACTURER OF SAGINAW POWER STEERING FOR PASSENGER CARS, TRUCKS AND TRACTORS

Subjected to toughest hose test . . . yet

still OK after 147,000 shock loads

TEST CONDITIONS ON IMPULSE TESTER
(A) 14 impulses per minute. (B) Min. pressure rise: 34,000 psi/sec. (C) Max. pressure rise: 50,000 psi/sec. (D) Peak impulse pressure: 125% of working pressure.

RESISTOFLEX INDUSTRIAL HYDRAULIC HOSE ASSEMBLIES
offer high burst strength, too!

The hydraulic impulse test, as outlined in military spec. MIL-H-5511, shows how well these *industrial* hose assemblies resist fatigue.

To this 100,000 cycle test, while plenty tough by itself, Resistoflex added a 160°F requirement—making it the toughest hose test yet. Despite this, Resistoflex medium-high pressure assemblies were still going strong after 147,000 cycles . . . at which time attempts to fatigue the assemblies were abandoned as futile.

Built with tough compar tube and high strength synthetic fibre-braid reinforcement, Resistoflex hose assemblies also provide five other features for *more hose value per dollar:*

1. **High burst strengths – stay high even as working age increases.**
2. **High pull strength – more than 3500 lbs. for ½" hose. Couplings won't pull out even under this tension!**
3. **High impact strength – hose returns to original cross section after crushing load.**
4. **Full flow fittings – fitting bore equals hose I.D. – Hose constriction at crimp is less than 5%.**
5. **No gumming or clogging of hydraulic circuit – Compar tube inert to all hydraulic oils.**

I.D. (Inches)	Working Pressure (psi)	Min. Burst Pressure (psi)	Assembly Tensile Strength (lbs.)
¼	2300	9200	900
⅜	2050	8200	2500
½	1800	7200	3500

Write for Data Sheet MH-16.

RESISTOFLEX
CORPORATION
Belleville 9, New Jersey

SPECIALLY ENGINEERED FLEXIBLE RESISTANT PRODUCTS FOR INDUSTRY

Finite Amplitude in Ducts (Abstract) by R. E. Meyer; *On the Problem of Separation of Supersonic Flow from Curved Profiles* by T. Y. Thomas; *On The Construction of High-speed Flows* by G. F. Carrier and K. T. Yen; *An Example of Transonic Flow for the Tricomi Gas* by M. H. Martin and W. R. Thickstun; *On Gravity Waves* by A. E. Heins; *Hydrodynamics and Thermodynamics* by S. R. DeGroot; *Nonuniform Propagation of Plane Shock Waves* by J. M. Burgers; *Theory of Propellers* by Therodore Theodorsen; *Numerical Methods in Conformal Mapping* by G. Birkhoff, D. M. Young and E. H. Zarantonello; *Flow of Viscous Liquid through Pipes and Channels* by J. L. Synge; and *The Method of Singularities in the Physical and in the Hodograph Plane* by Alexander Weinstein.

Elements of Physics

GEORGE SHORTLEY, *Ph.D., Operations Research Office, The John Hopkins University; and* DUDLEY WILLIAMS, *Ph.D., Prof. Of Physics, The Ohio State University.* 778 *pp,* 6 x 9 *in., Published by Prentice-Hall, Inc.,* 70 *Fifth Ave., New York* 11, *N. Y.* $10.

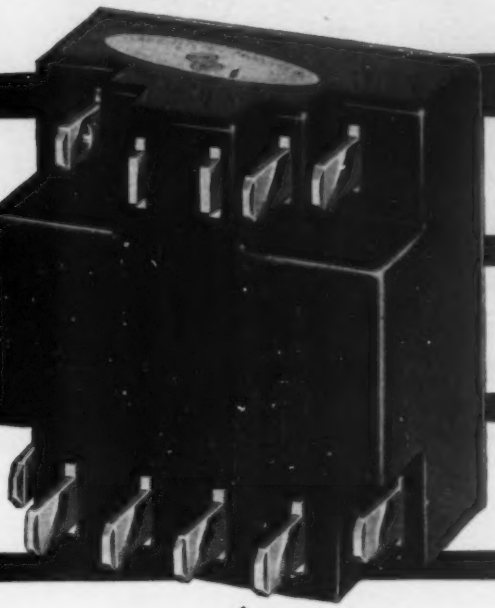
This book has been written for use as a text in an introductory course in physics such as is normally taken by students of science and engineering. It is a rigorous introduction to fundamental principles in which nothing will have to be 'unlearned' when the reader takes up more advanced work.

Concepts of modern atomic physics are introduced wherever they aid in reaching an understanding of the basic phenomena. Part VI on Modern Physics gives the new fundamental principles that represent twentieth-century developments, and show that these principles do not supplant, but merely supplement, the older principles.

Two systems of mechanical units and one system of electromagnetic units are used: For mechanical relations, the gravitational British-engineering system and the absolute MKS international metric system—one gravitational and one absolute system; one British and one metric system. For electricity and magnetism, only the practical MKS system in its rationalized form is applied. In the Appendix,

LOOKING FOR Something New IN SWITCHES?

(This one helps SELL room air conditioners)



POSITION I
"VENTILATE"
(Evaporator, on full)

POSITION II
"EXHAUST"
(Condenser, on full)

POSITION III
"COOL and EXHAUST"
(Evaporator, on low; Condenser, on full; Compressor, on)

POSITION IV
"DEHUMIDIFY"
(Same as position III)

POSITION V
"SUMMER COOLING"
(Evaporator and Condenser, on full; Compressor, on)

POSITION VI
"SLUMBER COOLING"
(Evaporator and Condenser, on low; Compressor, on)

POSITION VII
"HEATING"
(Evaporator, on full; 1250-watt heater, on)

POSITION VIII
"OFF"

Special 8-POSITION switch
MODEL 190

The designing and building of *circuit selector switches* is an important part of Ferro's business. And we're not too big to fuss with *your* special requirements, provided the potential production volume justifies the effort—*both* for you and for us.

Whether your problem is one of space and compactness or the best handling of an intricate wiring pattern, you'll find interested, competent "first aid" here at Ferro. You'll find also that the finished product is *right* due to our small labor turnover and rigid testing and inspection system.

Illustrated above is one of our more elaborate switches. Shown at the right is a simple, 3-position model. Somewhere between the two may be the special switch you are looking for. *Why not write* and tell us your requirements?

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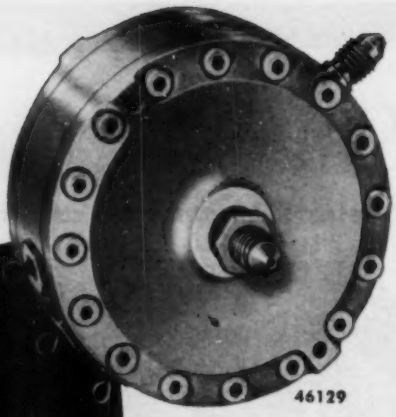
transmission of pressure information



46129

Giannini

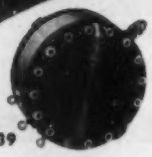
RESISTANCE TYPE
GAGE • ABSOLUTE • DIFFERENTIAL

ACCURATE
SMALL SIZE
RUGGED
LIGHTWEIGHT

High Pressure Transmitters

Giannini pressure transmitters accurately translate pressure into proportional electrical signals of relatively high power — signals, that require little or no amplification for utilization. These high pressure transmitters incorporate a unique, direct-coupling arrangement between bourdon tube and potentiometer element which obtains movement amplification without the use of gearing or linkage, thus giving high sensitivity, repeatability, and low hysteresis. Specific models are available for operation under either normal or extreme conditions of vibration and acceleration.

Models also available for low pressure and high altitude applications.



46139

46118

46119

MODEL	WEIGHT	GAGE	ABSOLUTE	DIFFERENTIAL
* 46129	0.75 lbs.	0-100 psig up to 0-600 psig	15-100 psia up to 15-600 psia	0-100 psid up to 0-600 psid
46118	0.3 lbs.	0-100 psig up to 0-6500 psig	0-100 psia up to 0-500 psia	0-100 psid up to 0-600 psid
* 46119	0.6 lbs.	0-100 psig up to 0-6000 psig	0-100 psia to 0-600 psia	0-100 psid to 0-600 psid
46139	0.75 lbs.	0-100 psig up to 0-6500 psig	NONE	NONE

Standard Resistance 2,000 ohms. * For Corrosive Media.
For specific values of linearities, resolution, repeatability and hysteresis, write for bulletins.

Giannini INSTRUMENTS CONTROLS

G. M. GIANNINI & CO., INC. PASADENA 1, CALIF. EAST ORANGE, NEW JERSEY

these systems are related to other systems and extensive tables of conversion factors are given.

The authors believe it important to acquire a 'feeling' for the dimensions of physical quantities. To this end they, carefully point out the way in which the various units are derived from a small number of fundamental units, and emphasize the fact that all valid equations must 'balance' dimensionally. The basic principles of dimensional analysis are taught, not explicitly, but implicitly by an insistence on careful attention to units.

Mathematics is used as a tool, and no attempt is made to teach mathematics for its own sake. Plane trigonometry is used extensively from the beginning, but calculus ideas are introduced gradually, as the student may be expected to acquire a familiarity with this discipline in a concurrent course. The arrangement of the first four chapters is conditioned by the fact that the understanding of kinematics is so greatly facilitated by using the ideas and notation of differential calculus that it seems worthwhile, at the expense of some repetitiveness, to postpone the treatment of kinematics until a working knowledge of the use of the calculus for the expression of 'irates' has been acquired.

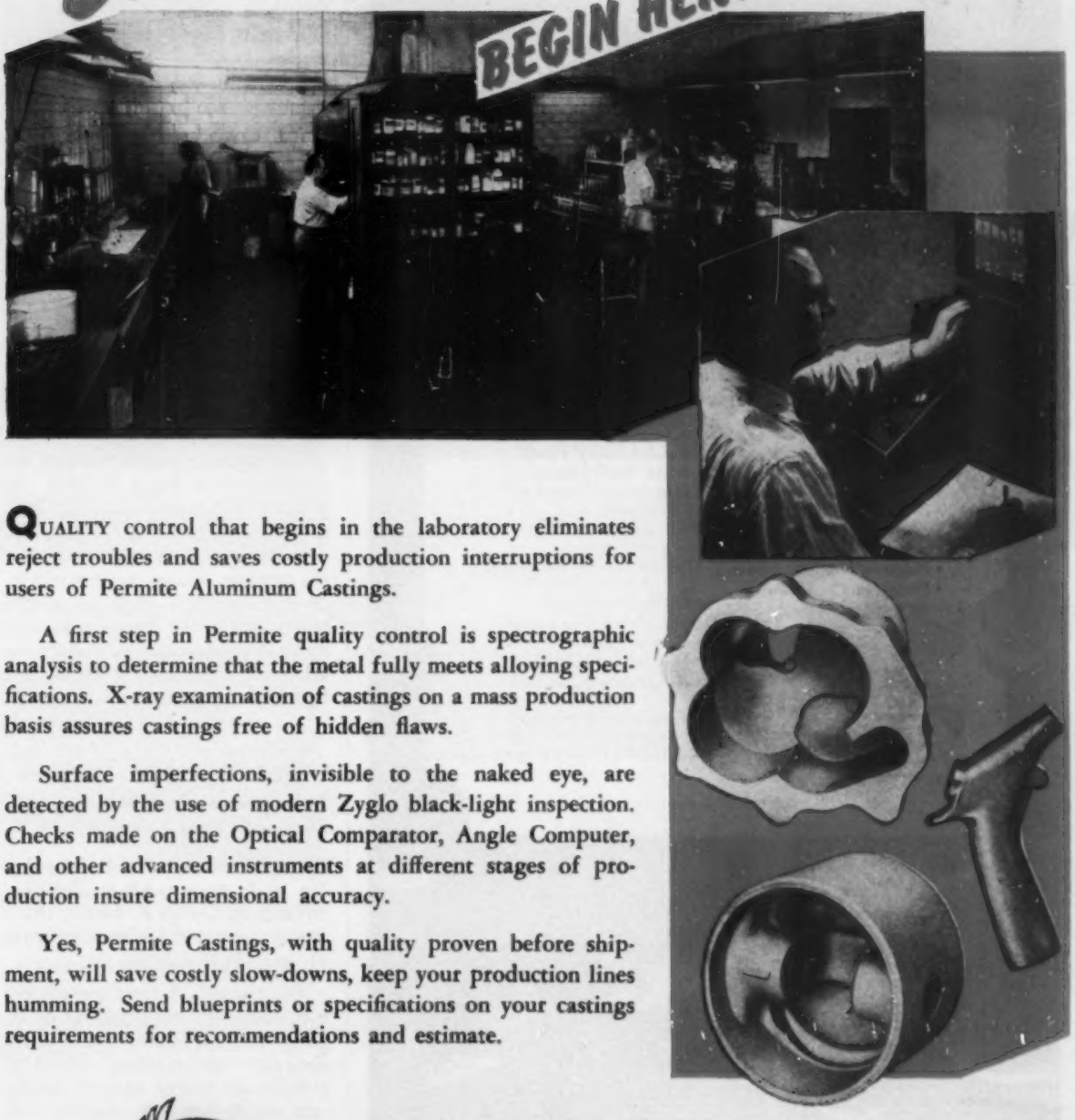
Included are more problems than are usually worked in an introductory course, with answers given for the odd-numbered problems only. These problems are carefully 'graded,' and offer a range from simple substitution problems to some of considerable complexity involving derivations and proofs. Because drill on experimental accuracies and significant figures, while very important, belongs largely in the physical laboratory, answers are generally given to only three significant figures and the data are expected to be treated as exact numbers.

History of Strength of Materials

STEPHEN P. TIMOSHENKO, *Professor of Engineering Mechanics, Stanford University.* 452 *pp*, 6 x 9 *in. Published by the McGraw-Hill Book Co.*, 330 *W.* 42*nd St., New York* 36, *N. Y.* $10.

Here is a book for students of engineering mechanics, who, having

SAVINGS for Users of PERMITE ALUMINUM CASTINGS



QUALITY control that begins in the laboratory eliminates reject troubles and saves costly production interruptions for users of Permite Aluminum Castings.

A first step in Permite quality control is spectrographic analysis to determine that the metal fully meets alloying specifications. X-ray examination of castings on a mass production basis assures castings free of hidden flaws.

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• Crown Glass Wedge Type Prisms
• Equilateral 60° Prisms
• Right Angle Prisms
• First Surface Reflectors —Plane
• Second Surface Reflectors —Plane
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1853/1953
INTO A NEW CENTURY OF OPTICAL PROGRESS
BAUSCH & LOMB CENTENNIAL
WRITE for catalog, and for information on special orders. Bausch & Lomb Optical Co., 66819 St. Paul St., Rochester 2, N. Y.

knowledge of strength of materials and theory of structures through completion of courses in those fields, wish to pursue their search further. This book presents the history of the development of the science of strength of materials from its beginnings to the present.

Because there is an inextricable interrelation between the sciences of theory of elasticity and theory of structures with that of strength of materials, the author includes those portions of their histories which have a close connection with and bearing upon his major subject.

Handled chronologically, the text treats the developments of the sciences by periods of history. Within these periods, major contributions made by prominent scientists and engineers are related in brief biographies to give a complete, as well as vital picture of developments.

Coming up to present there are discussions which bring together the progress of strength of materials with the state of engineering education and with development of industries in various countries. These considerations include the modern effects of railroad transportation, the use of steel as a major structural material, and the development of combustion engines and light airplane structures.

Digital Differential Analysers Monographs Number One and Two

GEORGE F. FORBES, *No.* 1—14 *pages, No.* 2—29 *pages,* 6 x 9 *in. Published privately by George F. Forbes,* 10117 *Bartee Avenue, Paconima, California.* $1. *each,* $1.75 *together.*

The purpose of these monographs is to enable the mathematician or engineer to most effectively utilize the equipment and personnel service of a digital differential analyser installation, and to enable the analyser technician to more fully understand the mathematical and analogue problems involved in using the machine. Although the presentation is as simple as possible, a mathematical background consisting of two semesters of calculus and one semester of differential equations is required.

The treatment is on a calculating machine or an analogue machine basis

New facts for your file on

U·S·S HIGH STRENGTH STEELS

U·S·S COR-TEN steel increases strength and durability of ironer parts . . . materially reduces die maintenance costs here

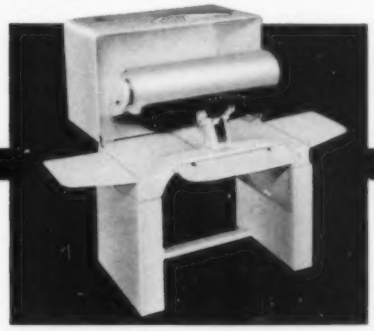
● Ironrite, Incorporated, Mt. Clemens, Michigan, manufacturers of the Ironrite Ironer, reports the following results since they switched from carbon steel to U·S·S COR-TEN steel for cabinet, wings and lapboard:

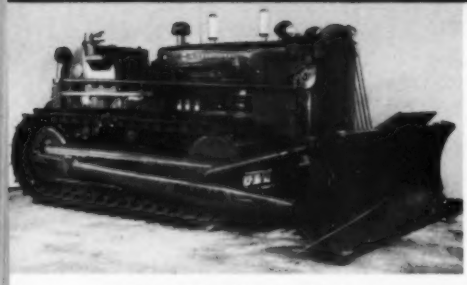
1. They obtain a sturdier, more durable, longer-wearing cabinet, because U·S·S COR-TEN steel has a yield point 50% higher than carbon steel and offers much greater resistance to dents.

2. Ironer parts have a smoother, more even finish, because COR-TEN steel offers much better adherence to baked enamel than carbon steel.

3. Their die maintenance costs are materially reduced. Dies wear longer, require less maintenance, because U·S·S COR-TEN steel is consistently uniform in quality and flows smoothly and evenly in the dies.

4. Lapboard and wings are stronger—yet weigh less. The greater strength of U·S·S COR-TEN steel makes it possible to use it in lighter gages than carbon steel. This reduces the amount of steel required, yet assures greater stiffness and durability.





U·S·S COR-TEN steel gives greater strength and corrosion resistance to earth-moving equipment

In this ruggedly-designed bulldozer, built by Pullman-Standard Car Manufacturing Company, moldboard face plates have greater strength and increased corrosion resistance because they are made with U·S·S COR-TEN steel. This superior high strength steel has been used for many years in all sorts of heavy-duty earth-moving and materials-handling equipment. Its use increases strength due to a 50% higher yield point, assures 4 to 6 times the atmospheric corrosion resistance of regular carbon steel, and provides greater resistance to impact and abrasion—all benefits that can be obtained at absolutely no increase in weight.

IN 1933 the first heat of U·S·S High Strength Steels was shipped to a customer. Since then over 2 million tons of these "steels that do more"—U·S·S COR-TEN, U·S·S MAN-TEN and U·S·S TRI-TEN—have been produced. They have been used to make more than 170,000 freight cars lighter or stronger . . . to build buses lighter and safer . . . to reduce weight in trucks so they can haul more payload . . ..to make mine equipment and earth-moving machinery stronger and tougher . . . to give the farmer sturdy and durable tractors and implements. L-P gas cylinders, water heaters, and a multitude of other products last longer, weigh less—making them easier to handle—and cost less to ship when made with U·S·S High Strength Steels. If you'd like to add their money-saving advantages to your product, write us. United States Steel Corporation, Room 2813-E, 525 William Penn Place, Pittsburgh 30, Pennsylvania.

1933 UNITED STATES STEEL USS HIGH STRENGTH STEELS 1953

TWENTY YEARS OF PERFORMANCE

Rubber-curing chamber is lined with U·S·S COR-TEN steel to provide resistance to deterioration

Foamex cushions at Firestone Industrial Products Company's, Fall River, Massachusetts plant, are processed in this curing chamber, 340 feet long, 10 feet wide and 6 feet high. When in operation, steam at atmospheric pressure fills the chamber—constant wetting and drying induces corrosive action that deteriorates ordinary steel construction. To overcome this, the manufacturer, Mechanical Handling Systems, Inc., Detroit, Mich., lined the chamber with U·S·S COR-TEN steel, which has 4 to 6 times the resistance to atmospheric corrosion of plain steel. User is reported highly pleased with results.

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UNITED STATES STEEL

New facts for your file about

U·S·S STAINLESS

Stainless Steel tubes take the place of refractories in furnace recuperators

Result is elimination of leakage, increased production and savings in fuel

● Taking over a job once performed almost exclusively by other materials, Stainless Steel is giving outstanding performance in recuperators made by Hazen Engineering Company, Pittsburgh, Pa. Hazen Recuperators—used with soaking pits and slab and billet heating furnaces—are all-metal units.

Various grades of Stainless Steel are used in Hazen Recuperator tubes. These tubes are often subjected to flue gas exceeding 2000°F. at the hot end of the recuperator.

Use of Stainless Steel offers many advantages in this application. They include:

1. Elimination of leakage because tubes are firmly secured at the top and free to expand and contract.

2. Reduction in start-up time of the recuperator because of rapid heat transfer through metal.

3. Flue gas deposits can be cleaned easily with no need for replacement of the entire unit.

4. Furnace efficiency remains high because individual tubes can be replaced quickly and easily from outside the furnace, eliminating necessity of cooling entire unit with accompanying lost time.

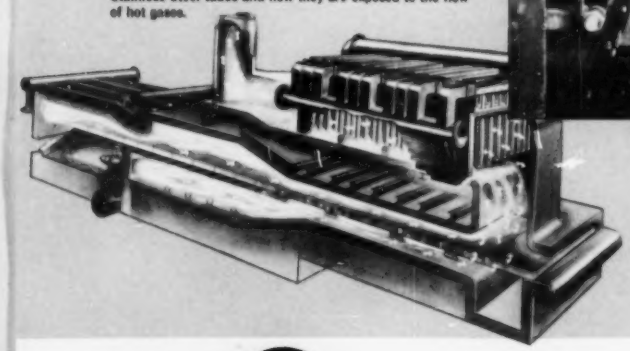
5. Increased furnace production due to the above factors.

6. Fuel savings result from retention of a high percentage of the heat value of the waste flue gases.

Nearly 100 of these Stainless Steel Hazen Recuperators have been installed to date. The oldest installation has been in service nine years.

Forming Stainless Steel sheet on a press brake for use in the Hazen Recuperator.

Cutaway drawing of a Hazen Recuperator showing the Stainless Steel tubes and how they are exposed to the flow of hot gases.



Heliarc welding of Stainless Steel for Hazen Recuperator.

USS

U·S·S STAINLESS STEEL

SHEETS · STRIP · PLATES · BARS · BILLETS · PIPE · TUBES · WIRE · SPECIAL SECTIONS

STEEL

Sink tops are formed from Type 430 Stainless Steel in a press brake at Geneva Modern Kitchens.

Major producer of kitchen sinks now uses Type 430 Stainless Steel

● When nickel-bearing grades of Stainless Steel were restricted in their use, Geneva Modern Kitchens, Geneva, Ill., experienced no difficulty whatever in switching production to straight-chromium Stainless Steel. Long before restrictions went into effect, Geneva had examined the possibilities of straight-chromium Stainless with good results.

Fabrication involves these operations. Type 430 Stainless sheets, 18 gage, are polished and coated with a protective plastic. Sheets are sheared and notched and the ends and sides are formed on a press brake.

The sheets are then blanked and bowl holes formed. The splash back is turned up on a press brake and drain grooves are formed. Bowls drawn from Type 430 Stainless Steel are electrically welded to the bowl holes, and welded areas and bowls are ground.

Bowls, top and sides of this attractive, durable kitchen sink are Type 430 Stainless Steel. The sink was manufactured by Geneva Modern Kitchens, Geneva, Ill.

Some hints on welding straight-chromium Stainless Steels

Most of the common commercial methods of welding can and are being applied successfully in the fabrication of straight-chromium grades of Stainless Steel. Methods being used include torch, arc, spot and resistance welding.

Welding temperatures should be kept as low as possible, since straight-chromium grades have a tendency toward grain growth which heat-treating may not correct. It has been found that in heavy sections numerous small beads followed by annealing often give the best results.

Tendency toward warping and movement in welding is minimized by the low coefficient of expansion of Type 430 straight-chromium Stainless.

Wherever feasible, it is recommended that welding rods be of nickel-bearing grades of Stainless Steel. But where color match is important, welding rods of a straight-chromium grade can be used successfully, especially when the weld is to be annealed.

Our representatives can help you with problems you may encounter in using U·S·S 17 (Type 430) and other straight-chromium grades of Stainless Steel.

UNITED STATES STEEL CORPORATION, PITTSBURGH · AMERICAN STEEL & WIRE DIVISION, CLEVELAND · COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO
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UNITED STATES STEEL

New facts for your file on U·S·S CARILLOY STEELS

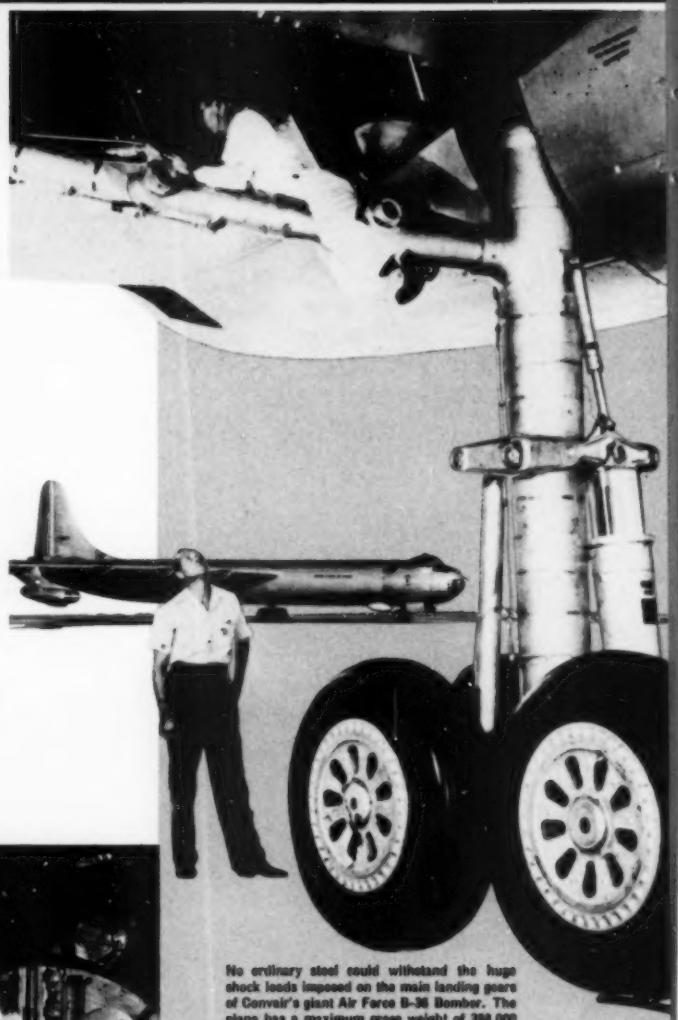
Every B-36 lands on U·S·S Carilloy steel

● When 179 tons of B-36 thump down on a landing strip, tremendous stresses are built up in the structural parts of the landing gear. Only the highest quality in steel can handle this tough job, which is one of the most exacting in the aircraft industry.

All of the rugged main columns for these landing gears are made from U·S·S CARILLOY electric-furnace aircraft quality ingots. This high quality alloy steel provides the great strength and shock resistance demanded in the performance of the finished part. The main columns for these landing gears are forged. The original ingot, as shipped to the forger, weighs approximately 37,500 lbs. From it are produced two columns, each weighing about 1200 lbs. In other words, approximately 93% of the steel has been removed—with a mere 7% of the original ingot left to do this tremendous job. Obviously, this steel must be of the very best quality.

The same care and skill go into every ton of CARILLOY steel that *you* buy, whether it's a giant alloy ingot or a few tons of special steel. Our experienced metallurgists keep a close check on *every* heat of steel to make sure it has the strength, hardness, toughness and machinability that's needed.

If you have a special steel problem, let us know. We'll be glad to help you with it.



No ordinary steel could withstand the huge shock loads imposed on the main landing gears of Convair's giant Air Force B-36 Bomber. The plane has a maximum gross weight of 358,000 lbs., with still higher landing shock loads. But U·S·S Carilloy steel has more than enough impact strength to hold up under this severe punishment.

U·S·S Carilloy electric-furnace aircraft quality steel meets every requirement for these vital parts. The precision machining and expert heat treatment they get at Cleveland Pneumatic Tool Company complete the job.

USS

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UNITED STATES STEEL

depending on which approach best applies to the particular problem being covered. The emphasis is on the capacity and limitations of the equipment, and upon the preparation of a network schematic which adequately represents the given problem. The schematic should contain all of the information required for the digital differential analyser technician to translate it into the proper coding system.

Monograph Number One includes the basic operating principles and the fundamentals of schematic design and scaling. Monograph Number Two includes material on the noninteger schematic system, functions of two variables, the exponential function and the sine and cosine.

American Electrician's Handbook

TERRELL CROFT, *Consulting Engineer. Revised by* CLIFFORD C. CARR, *Head of Dept. of Electrical Engineering, Pratt Institute.* 1,773 *pp*, 5 x 7½ *in. Published by McGraw-Hill Book Co., 330 W. 42nd St., New York 36, N.Y.* $10.

Although intended primarily for practical men in the electrical field, such as wiremen, contractors, linemen, etc., this book may be of interest to many design engineers. Fully revised in accordance with the 1951 National Electrical Code, this Seventh Edition has data on subjects ranging from the fundamentals of electricity to practical suggestions for remedying the troubles of electrical equipment. It includes data and suggestions that are essential for the selection, installation, operation, care, and proper application of many different types of electrical apparatus and materials.

Besides covering all the basic electrical jobs, it includes authoritative information on such subjects as electron tubes and circuits, fundamentals of construction, operation and application of electronic devices in industry, control generators (Amplidyne and Rototrol), electronic control of motors, automatic electric drive control, synchros, dry-type transformers, copper-oxide and selenium rectifiers, Signalite fuses, thermoplastic insulated wire, load-center industrial distribution system, fluorescent-lamp developments, and interior and exterior wiring.

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3. A FENWAL THERMOSWITCH CONTROL may solve your problems, too. Its external, single-metal shell expands or contracts *instantly* with temperature changes, making or breaking enclosed electrical contacts. Compact, highly resistant to shock and vibration, Fenwal THERMOSWITCH units have solved hundreds of otherwise costly problems.

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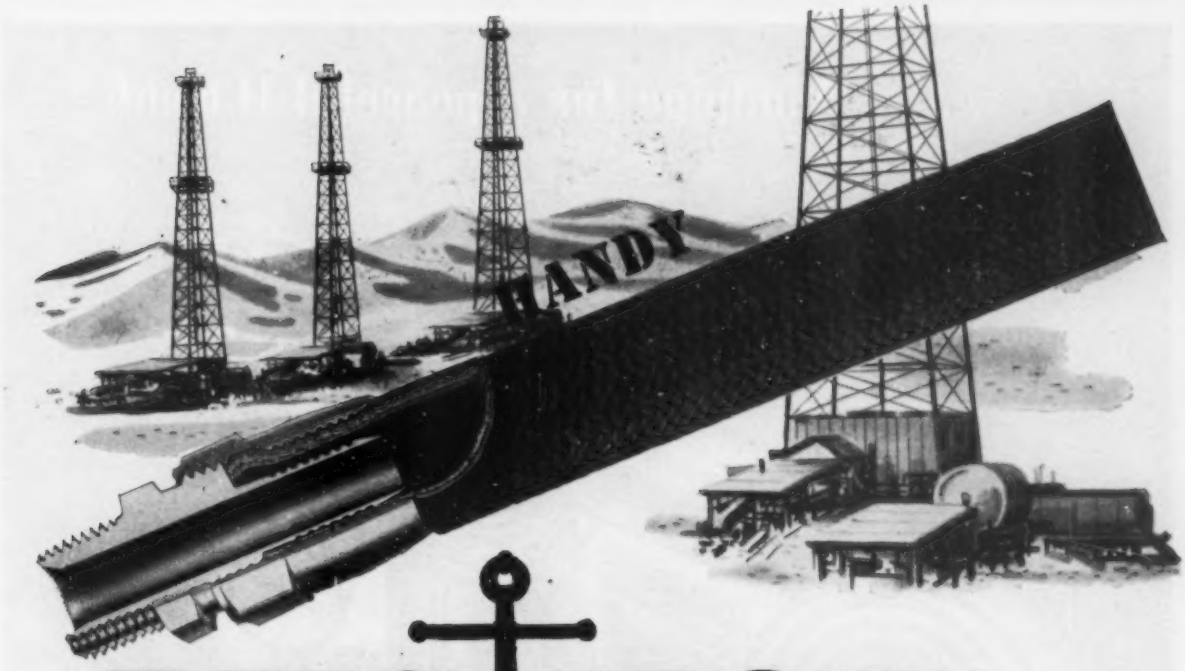

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Expensive downtime eliminated — repairs made immediately on the job without special tools.

Easy to assemble — vise, oilcan, and wrench are the only tools needed to assemble couplings and hose.

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Can be used over and over.

Ample flow capacity.

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SPLIT-FLANGE CLAMP
Positive leakproof connection without threaded joints. Bolt centers are located to distribute the forces evenly and prevent tilting of the clamp halves.
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Find out how Anchor reusable couplings for type QW hose save time, trouble, money. Attach coupon to your letterhead and mail today.

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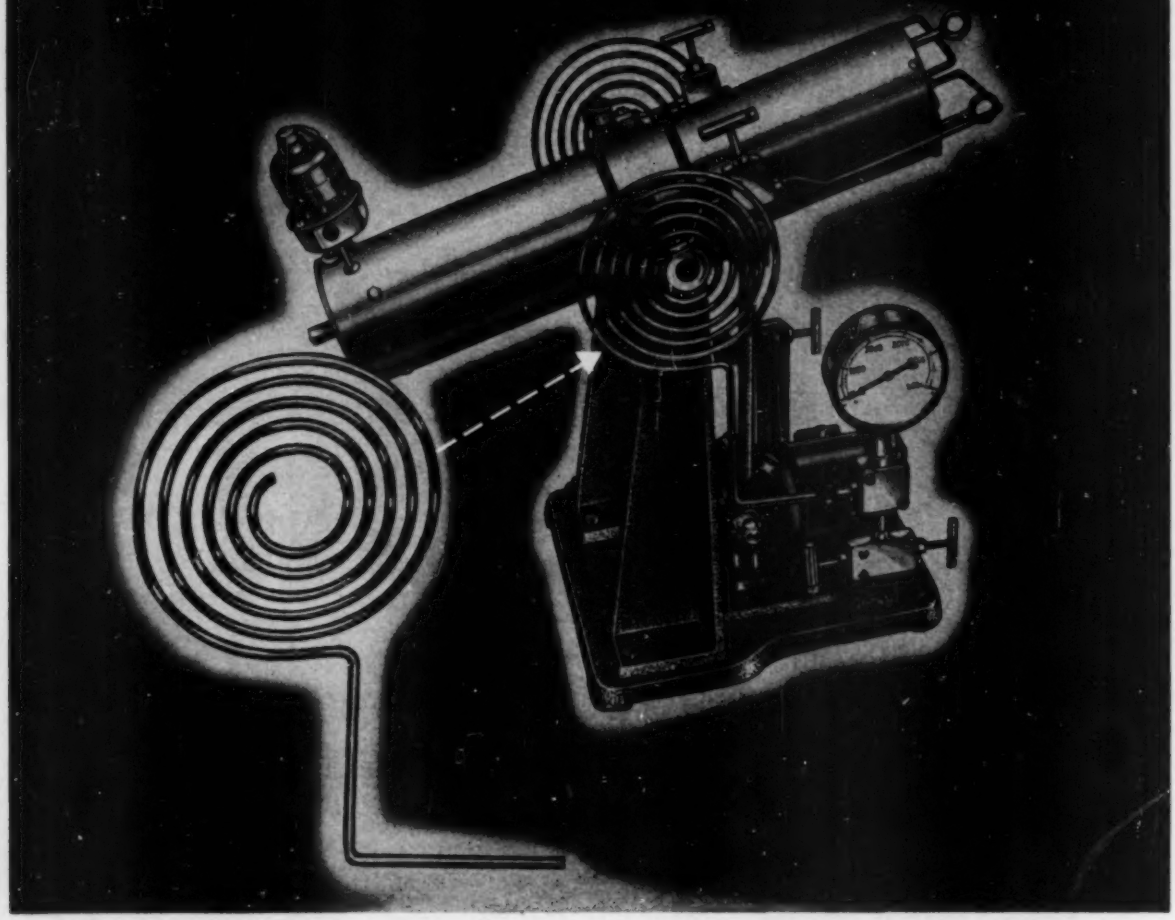
Windpipe for a peaceful H-bomb



You can call it an H-bomb if you like. Some people do. Technically, it *is* a hydrogenation bomb or, simply, a super-pressure vessel. Uses for it are legion but not warlike.

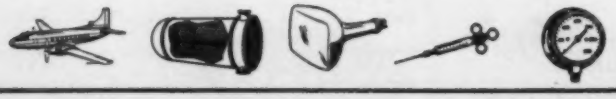
Researchers in rubber, plastics, pharmaceuticals, petroleum, and solvents pilot their hydrogenation, oxo-reaction, polymerization and other jaw-breaker problems in its gizzard—under high pressure.

To speed-up chemical reactions, the vessel is rocked 38 times a minute. Pressurizing a see-sawing chamber is in itself a neat trick: when pressures of the order of 60,000 p.s.i. are required you might become discouraged or concerned.

American Instrument Company, Inc., maker of Super-pressure equipment, introduces the pressure through a spiral windpipe. They had some trouble through tube breakage but that was before they tried Superior 304 Cold-drawn Seamless Stainless Steel Tubing. Superior gives them just the flexibility and fatigue strength needed for cyclic operation, plus chemical resistance and burst pressure to spare. Spirals of Superior 304 are easier to bend, last longer. And American Instrument reports them dimensionally uniform, smooth and free from surface imperfections.

If you haven't found small tubing in the analysis, size, and finish you want, or if you think there's little difference in tubing or tubing experience, Superior invites your inquiry. Superior Tube Company, 2012 Germantown Avenue, Norristown, Pennsylvania.

Round and Shaped Tubing available in Carbon, Alloy, and Stainless Steels; Nickel and Nickel Alloys; Titanium, Zirconium, and Beryllium Copper



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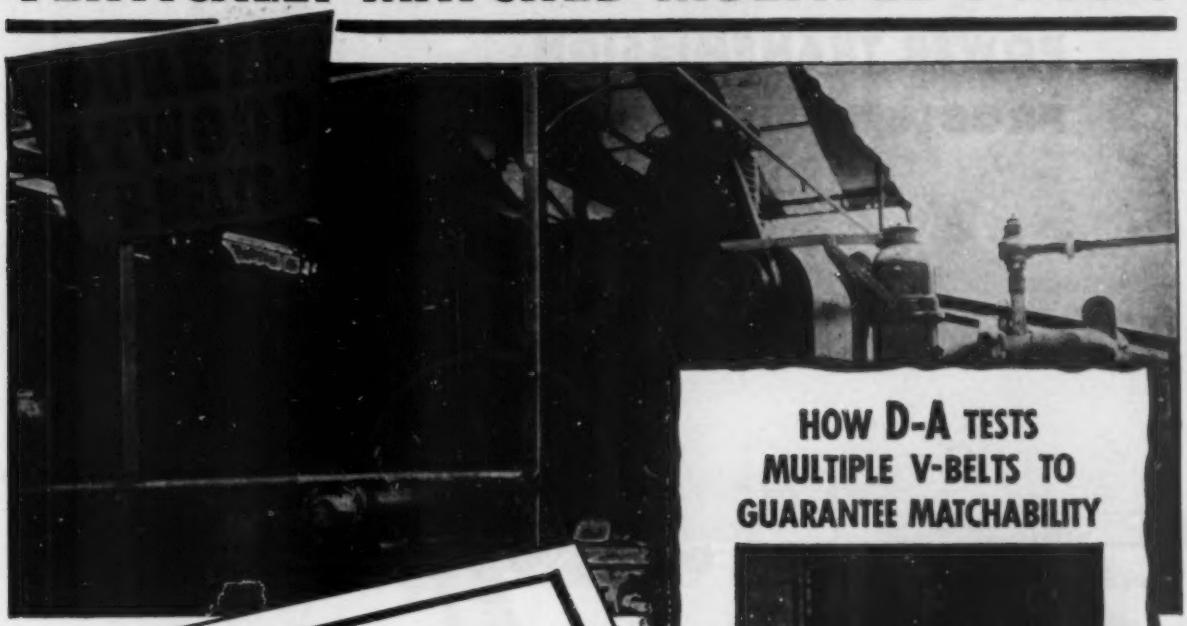

PERFECT MATCHING...
Vertical matching eliminates the "sag" error always present in V-belts matched on horizontal matching equipment.
WE DON'T MATCH THE SAG

HOW D-A TESTS MULTIPLE V-BELTS TO GUARANTEE MATCHABILITY

New vertical V-belt testing machine tests under varied tensions up to 450 lbs. per belt. This calibration of true belt running length assures equal power transmission per strand on multiple belt drives. Machine tests for vibration from minute variations in cross sections, also detects internal imperfections. Each D-A multiple belt is tested individually to guarantee perfect matchability.

MR. DESIGN ENGINEER:

Durkee-Atwood Industrial V-Belts are designed and manufactured for machines from steak tenderizers to rock crushers. In the above photo they are shown being used on oil field equipment.

No matter how large or how small the machine, there are Durkee-Atwood V-belts to do a better job. Every belt gets that special attention in construction and engineering details that provide longer belt life and top performance . . . two *extra values* to look for when selecting Industrial V-belts.

Factory vibration-tested belts assure better performance for the air conditioning industry.

Write Dept. PE7 for D-A 60-page engineering catalog containing new RMA-approved INCREASED HP ratings for Industrial V-belts.

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DURKEE-ATWOOD COMPANY Minneapolis 13, Minnesota

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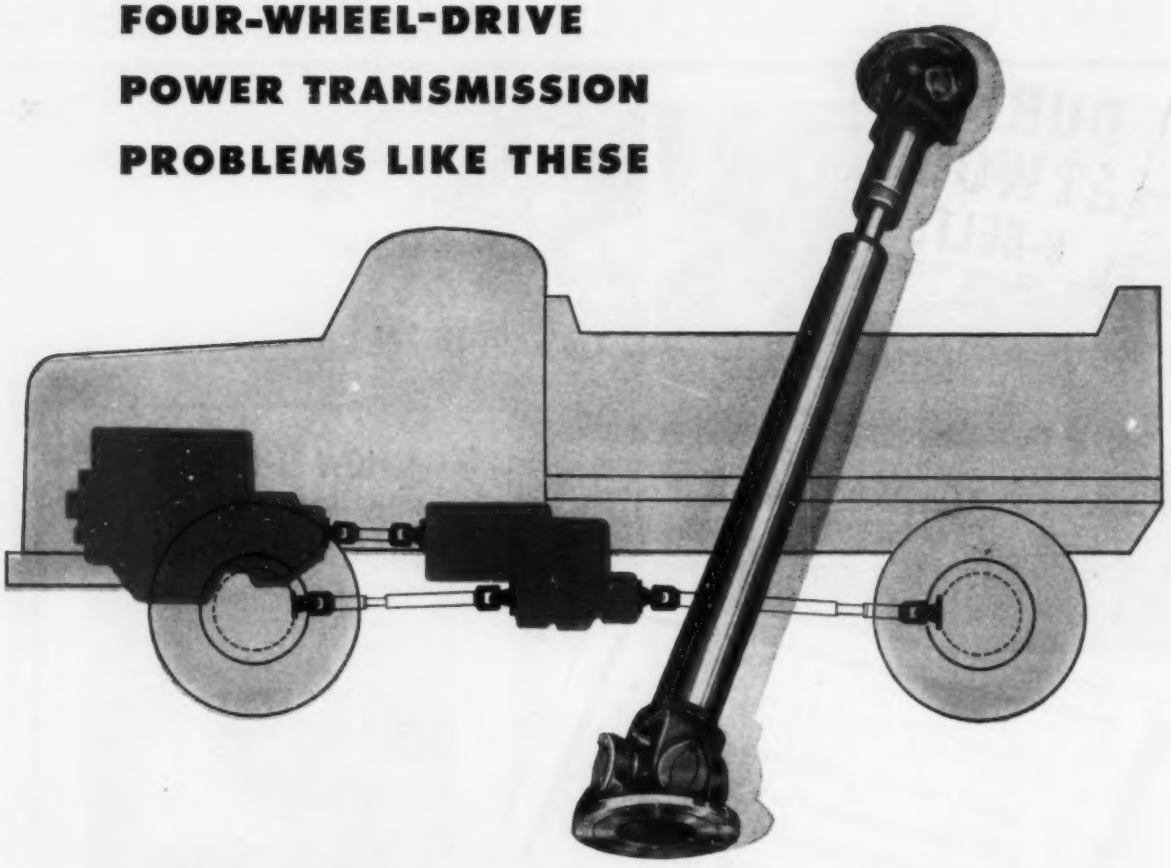

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LANDING THE F-86 SABRE JET ON TWO FINGERS... FINGERS FORGED BY UTICA

When the North American F-86 Sabre Jet swoops in for a landing, two steel fingers control the landing shock. Like fingers in a dike, the pins meter hydraulic fluid through a small orifice to cushion the landing. Varied contour of the pin serves to vary resistance developed.

These pins are UTICA forgings, and point up an unusual development story. Under conventional forging methods, they would be expensive to produce because of immense machining required. Forging is practical only because UTICA has a "short-cut" production method for upsetting far greater than the standard three diameters.

They start by upsetting 15⅓ diameters

Each pin starts as a ¾" diameter, 21½" bar of SAE 4130. In one of UTICA's electrical upsetting machines 11½" is upset—*more than half the bar and, actually, 15⅓ diameters!* The bulb on the end is forged to rough shape, then machined to final dimensions. The UTICA forged part replaced the original part which was welded and required extensive machining. The new full-forged part has greater strength and requires much less machining. We are very proud the Cleveland Pneumatic Tool Co. picked UTICA Drop Forge for this important defense job.

New forging techniques ready for tomorrow

In defense production, UTICA has helped pioneer new techniques in forging both the old and the "new" hard-to-handle metals. Perhaps we can serve you—*tomorrow* . . . with forgings for advanced new products that will be tomorrow's leaders.

Our new booklet "File Facts on Precision Forgings" outlines UTICA'S methods and facilities, now totally engaged in defense production, but ultimately generally available. Send for your free copy.

Jobs available for technically trained personnel.

PRECISION···· U TI CA ····FORGINGS TRADE MARK

UTICA DROP FORGE & TOOL CORPORATION
UTICA 4, NEW YORK

MAKERS OF THE FAMOUS UTICA LINE OF DROP FORGED PLIERS AND ADJUSTABLE WRENCHES

Losing time on friction problems?

Let your J-M friction specialist speed your solution

YOUR FRICTION PROBLEMS need never be time-wasters when Johns-Manville industrial friction specialists are just waiting for a phone call or letter from you.

These experts will help you select the *right* friction material to solve your special problems quickly.

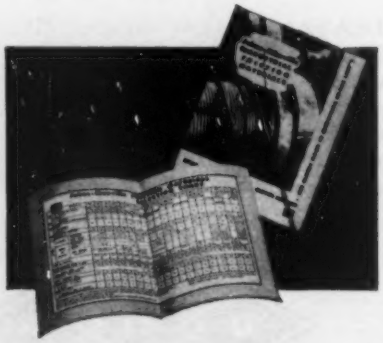
How can Johns-Manville give you this "Johnny-on-the-spot" service? Here's the story:

1. **We are pioneers** in the manufacture of friction materials for every type of equipment.
2. **We have built** up a storehouse of "know-how" by our contacts in supplying these materials to practically every type of industry.
3. **We maintain** one of the most extensively equipped laboratories in the world for the development of friction materials.

So regardless of your friction problem, don't lose time. Instead, phone or write your nearest Johns-Manville office—or write Johns-Manville, Box 60, New York 16, New York—and a J-M friction specialist will be on his way to help solve it in a hurry.

Here's your guide to the right friction material for the job—

Booklet FM-12A (right) is yours for the asking. It contains complete descriptions, specifications, and a handy selector chart. For your copy write Johns-Manville, Box 60, N. Y. 16, N. Y.



JOHNS-MANVILLE J-M PRODUCTS

Johns-Manville *Asbestos* FRICTION MATERIALS

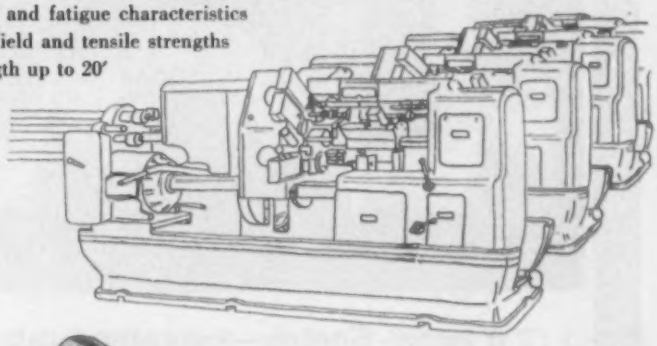
Customer Reports:

Asarco Continuous-Cast Bronzes Machined at Over 1,000 Feet Per Minute

WORTHINGTON CORPORATION has jumped machining speeds on shaft bushings and pump sleeves by using ASARCO Continuous-Cast Bronzes instead of foundry-cast bronzes. In some cases over 1,000 surface feet are machined per minute.

Worthington has used very substantial quantities of ASARCO Continuous-Cast Bronzes during the last three years in a variety of alloys and sizes. Tool life is longer despite high cutting speeds. Products are improved because ASARCO stock has greater uniformity than conventional foundry products, and its even dispersion of lead particles provides superior bearing surfaces.

ASARCO Continuous-Cast Bronzes are entirely free from porosity, and from hard and soft spots... are ideal for use on automatic screw machines. No sand, dirt, dross or other foreign matter is trapped in the stock to harm tools or discourage high cutting speeds. Dimensions are so precise that many machining operations are eliminated and waste is at a minimum. Impact and fatigue characteristics are up to 100% better than those of sand-cast bronzes. Yield and tensile strengths are superior, too. Stock is available in any length up to 20′ to meet individual requirements.



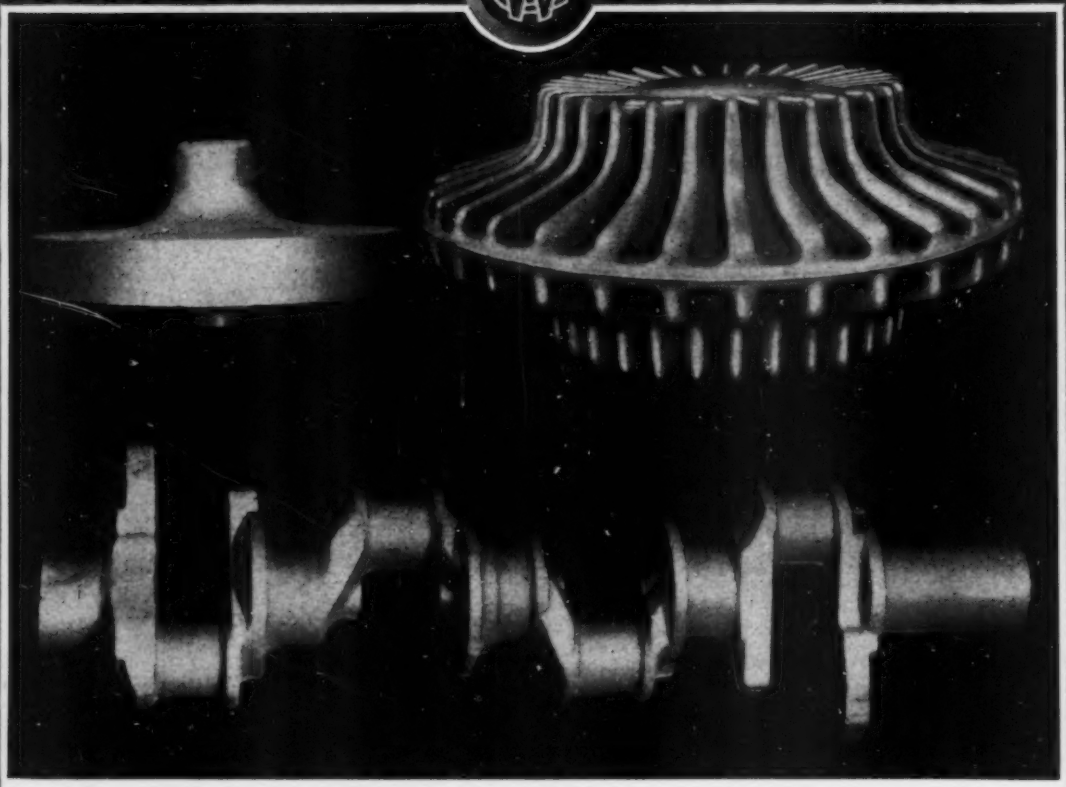
REDUCE MACHINING TIME! ... IMPROVE PRODUCTS! ... CUT SCRAP LOSSES! Buy ASARCO Continuous-Cast Bronzes and get bronzes with superior properties in the exact sizes you need.

ASARCO CONTINUOUS-CAST RODS TUBES SHAPES ®

West Coast Sales Agent:
KINGWELL BROS. LTD., 457 Minna Street, San Francisco, Calif.

American Smelting and Refining Company

OFFICES: Perth Amboy Plant, Barber, New Jersey
Whiting, Indiana



Wyman-Gordon — specialists in the vital forgings of the internal combustion engine since its inception—is today the largest producer of crankshafts for the automotive industry and of all types of forgings for the aircraft industry. Be it crankshafts and other vital forgings for the piston type engines or turbine wheels and impellers for turbo jets—there is no substitute for Wyman-Gordon experience.

Standard of the Industry for More Than Sixty-Five Years

WYMAN-GORDON

FORGINGS OF ALUMINUM • MAGNESIUM • STEEL

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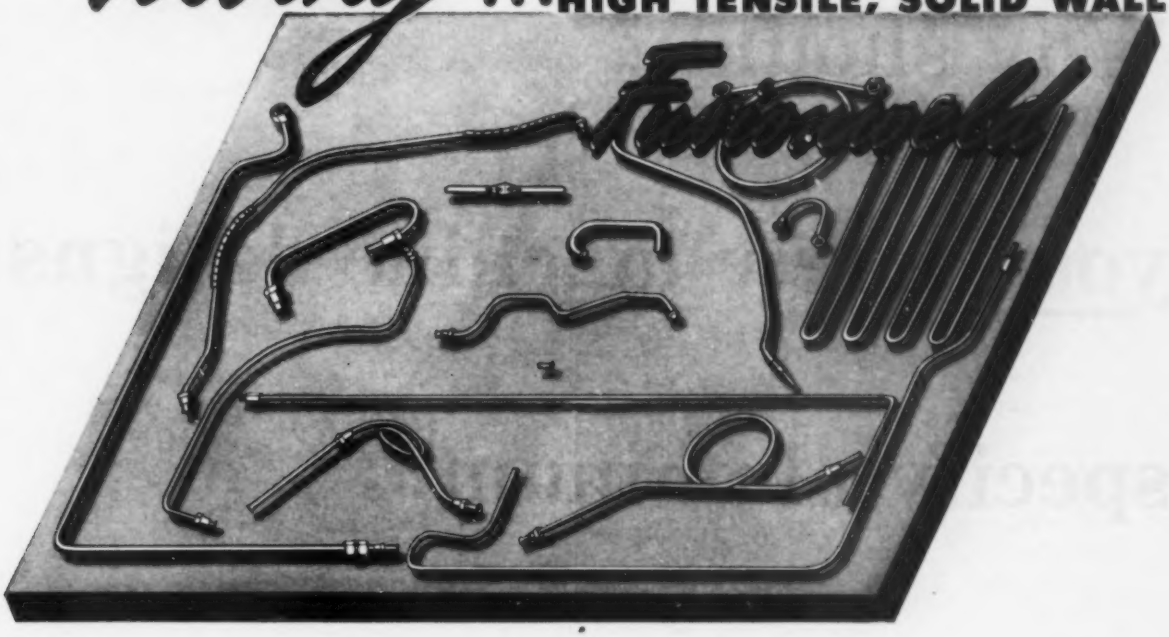
HARVEY, ILLINOIS DETROIT, MICHIGAN

Tubing ...HIGH TENSILE, SOLID WALL



FOR THE *Toughest* BENDING, FLARING, SWAGING, HI-PRESSURE SPECIFICATIONS

3/16" O.D. TO 5/8" O.D.
PLAIN OR TERNE COATED
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CURRENT CATALOG
ON REQUEST

● Avon Fusionweld—thin wall steel tubing—serves a constantly expanding variety of industrial needs . . . is fusion welded under a new, rigidly controlled hi-cycle process to insure uniformity of wall strength and structure . . . meets the highest standards for tensile strength, ductility, resistance to fatigue and pressures.

Available in straight lengths or continuous coils. May be specified "as welded" for miscellaneous commercial purposes; "hard drawn" in machining operations where threading, knurling, piercing, are specified; "annealed" to serve the most difficult problems of bending, flaring, swaging, beading and coiling without cracking, tearing or checking—to carry fluids under high pressures.

Widely used in automotive, refrigeration, air conditioning, space heater, stove, electrical, radio, TV and toy manufacturing industries. Post yourself on the superior economy and performance of Fusionweld—truly the tubing with a future! Let Avon help you find a more suitable answer to your tubing problems.

FUSIONWELD...*THE TUBING WITH A FUTURE*

AVON TUBE DIVISION HIGBIE MFG. COMPANY ROCHESTER, MICHIGAN

Why should

your screw machine designs

specify aluminum?

THERE ARE three *good* reasons why your screw machine parts should be made from *aluminum*—Kaiser Aluminum!

1. **Your raw material costs will be far less with aluminum!** The recent price increases in other nonferrous metals means that aluminum now gives you an even *greater* cost advantage than ever before. Aluminum gives you more machined pieces per pound because it weighs only ⅓ as much as other commonly used materials. And recoverable aluminum scrap is high in market value.

2. **You can improve your product with aluminum!** However diversified your screw machine designs may be, aluminum's unique combination of properties probably can greatly improve the quality of the finished part. These properties include: lightness, strength, corrosion resistance, heat and electrical conductivity, heat and light reflectivity and beauty.

3. **You can speed production with aluminum!** Aluminum alloys are ideal for automatic screw machine work. They are free machining and can usually be cut at high speeds and feeds to insure a high rate of production. And this fast production enables you to take advantage of the low raw material costs of aluminum.

Start now to profit with aluminum! Without obligation, Kaiser Aluminum engineers will be glad to give you their experienced assistance with alloy selection, design considerations and production techniques.

Prompt deliveries of round and hexagonal aluminum screw machine stock are now being made by us and our distributors. Our local number is listed in your classified telephone directory under the heading "Aluminum." Kaiser Aluminum & Chemical Sales, Inc., 1924 Broadway, Oakland 12, California.

Kaiser Aluminum

setting the pace—in growth, quality and service

They heated the "Outdoors"...in the 90's

A skyline of chimney pots was a striking sight in the 1890's... and a sign of heating inefficiency.

Compare the fireplaces and stoves of that day with modern central heating plants. Today's furnaces are marvels of efficiency in converting gas, oil and coal into clean, even heat that reaches every room.

Ever since 1908, when a furnace blower powered by an Emerson-Electric motor was introduced, we have been designing and producing motors for mechanical-firing and air-moving heating units. Many of the most famous names in the heating industry depend on Emerson-Electric motors for efficient, long-life operation for their products.

Ask us about Standard Motors in ratings from 1/20 to 5 H.P., and Hermetic Motor parts from 1/8 to 20 H.P.

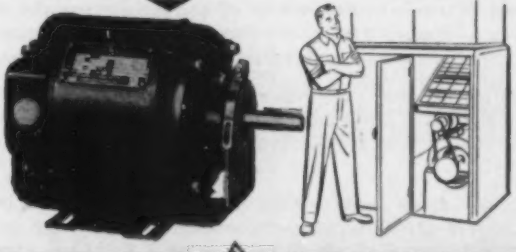
Write **THE EMERSON ELECTRIC MFG. CO., St. Louis 21, Mo.**

MODERN LIVING IS POWERED WITH ELECTRIC MOTORS

Write for these Emerson-Electric Motor Data Bulletins

Manufacturers requiring motors 1/20 to 5 h.p. can profitably use these reference guides. Specifications, construction and performance data are included for these motors:

- ☐ M454-A Capacitor-Start
- ☐ M454-B Split-Phase
- ☐ M454-C Integral
- ☐ M454-D Fan-Duty
- ☐ M454-E Oil-Burner
- ☐ M454-F Jet Pump
- ☐ M454-G Blower



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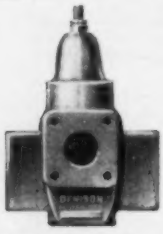
MOTORS • FANS APPLIANCES

LEADERS IN THE MOTOR AND FAN INDUSTRY SINCE 1890

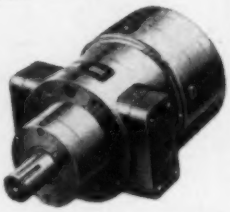
BUILT TO TAKE IT

longer, with less maintenance, at pressures up to 5000 psi

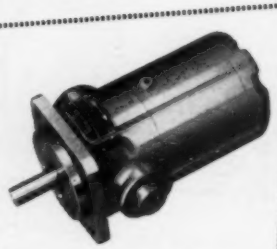
SURGE-DAMPING CONTROLS
Industrial and Aircraft Types
Eliminate Destructive Hydraulic Pressure Shock
¼" to 1" Sizes
For Pressures to 5000 psi
Catalog VS-1-A



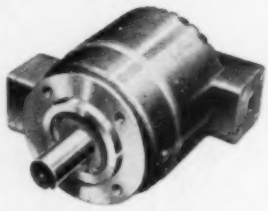
Direct-Operating PRESSURE CONTROLS
⅓" to 1½" Sizes
For Pressures to 2000 psi
Catalogs VRD-1 through VRD-8



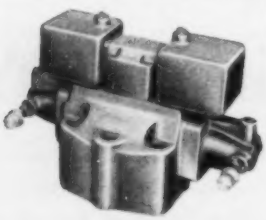
High-Pressure Axial-Piston PUMPS
Constant or Variable Volume
For 2500, 3000 and 5000 psi Circuit Needs
3.5 to 35 gpm Capacities
Catalogs P-4 through P-4-10



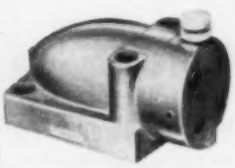
High-Torque Axial Piston FLUID MOTORS
Torque Ratings 13.8 to 112 inch-pounds per 100 psi (about 3 to 180 hp maximum)
For Pressures to 5000 psi
1500 to 3000 rpm
Catalogs FM-1, FM-2, FM-3-A



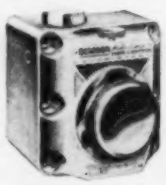
Dual-Purpose, Vane-Type PUMP/MOTOR
Ready for either pump or motor use without change
Shaft rotation in either direction
Four Sizes, 11 Models
Pumping Capacities: 3 to 82 gpm.
Motor Torque: 13 to 257 inch-pounds per 100 psi. Pressures to 2000 psi.
Bulletin P-5



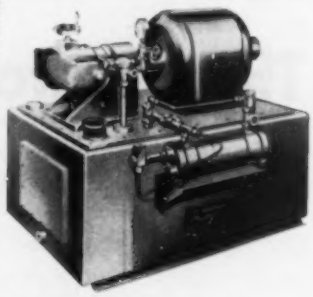
DIRECTIONAL CONTROLS
Manual, Mechanical, Electric or Pilot Control. ¼" to 2" Sizes
For Pressures to 5000 psi
Catalog VD-3



PRESSURE REDUCING VALVES
¾" to 1½" Sizes
20 gpm to 65 gpm Capacities
For Pressures to 5000 psi
Catalog VPR-1



Multi-Range FLOW CONTROLS
Full-Scale Regulation—Adjustable for Varying Input
¼" to ¾" Sizes
For Pressures to 3000 psi
Catalogs VFC-1, VFC-2



PUMPING UNITS
Constant and Variable Volume
46 Models—2 to 35 gpm Capacities
For Pressures to 5000 psi
Bulletins PU-3-A, PU-4 and PU-5

Denison HydrOILic PUMPS, MOTORS and CONTROLS

Proved in use—under many of Industry's toughest operating conditions—Denison HydrOILic Pumps, Motors and Controls are noted for their combination of high efficiency and rugged dependability.

In addition to fine performance under continuous, heavy-duty use, Denison HydrOILic Equipment offers space-saving design that simplifies circuit layout, makes installation easier, and minimizes maintenance problems.

Because so many users verify the extra value built into Denison Pumps, Motors and Controls, we continue the challenge made so often before—*let comparison prove to you* why they are first choice for so many needs of every type. Write today for full details on Denison HydrOILic Equipment to meet your requirements.

Pilot-Operated, Solenoid-Controlled DIRECTIONAL VALVES
Eliminate Spool-Sticking
¾" to 1½" Sizes, For Pressures to 5000 psi
Catalogs VD-1-1 to VD-4-2

Hydraulically Balanced PRESSURE CONTROLS
¾" to 2" Sizes
For Pressures to 5000 psi
Catalogs VR-2-B and VR-5-2

The DENISON Engineering Co.
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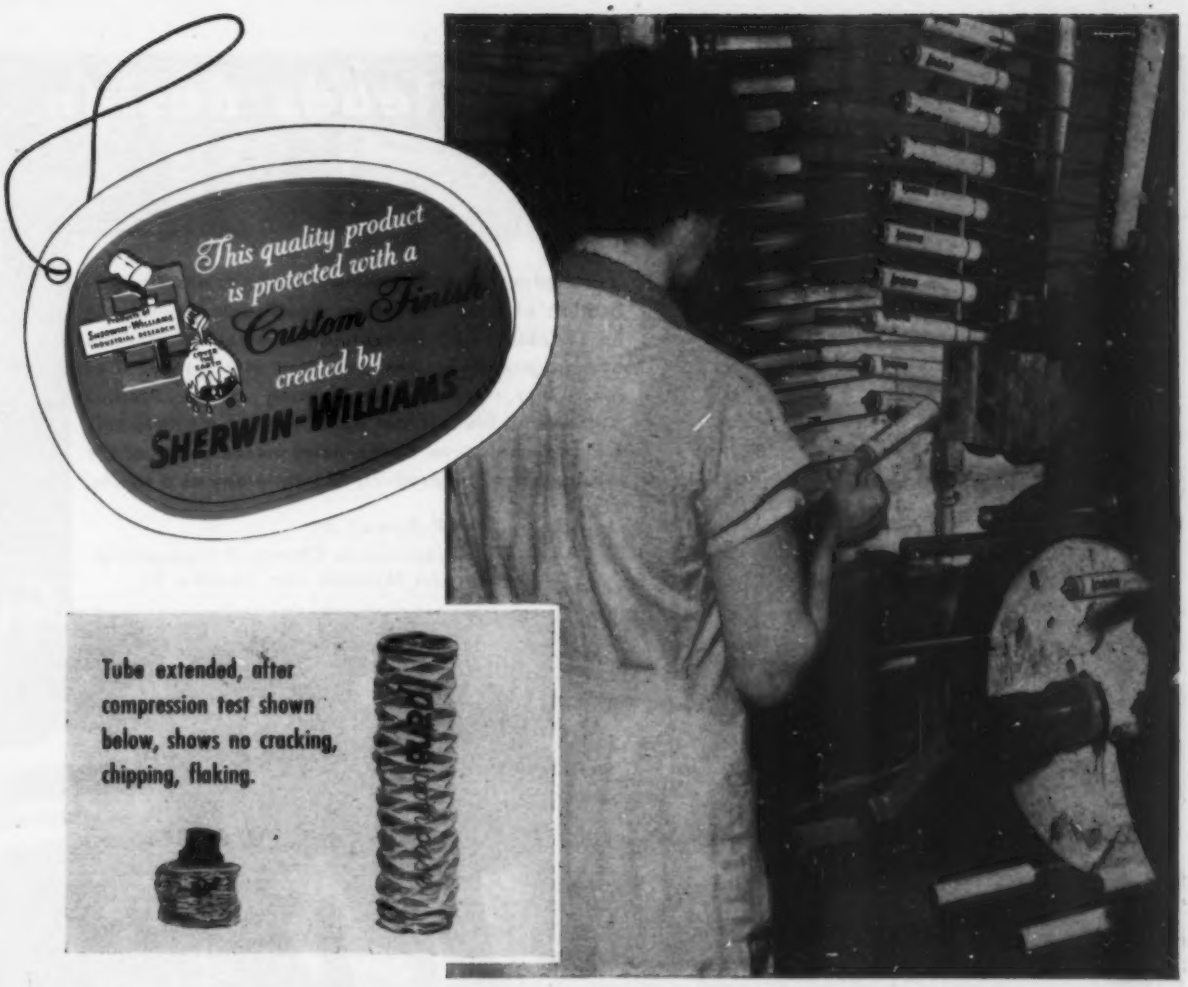
DENISON HydrOILics

"The Finest Money Can Buy!"



Tube extended, after compression test shown below, shows no cracking, chipping, flaking.

BIG SQUEEZE won't mar this finish

Ever squeeze a tube of shaving cream or tooth paste and have the paint flake off? That's what happens when ordinary finishes are used.

Sun Tube Corporation solved the problem for its customers. A Sherwin-Williams custom finish, applied under controlled conditions, practically fuses with the metal. The "big squeeze" you see here is proof . . . a myriad of accordion-like bends and sharp corners, yet the finish remains intact. Also, it has excellent chemical resistance.

Maybe you have a similar problem where flexing causes finish deterioration. Or perhaps you have a different problem, which can be solved with a specially formulated coating. Your Sherwin-Williams representative can offer qualified help . . . can bring you Sherwin-Williams' broad experience in providing the right finishing materials for widely varying requirements.

Ask him, too, about Sherwin-Williams identification aids—tags, seals or decals to help you feature the finish as a quality sales "plus". Or write for booklet B-767, "How to Make the Finish Help Sell the Product". The Sherwin-Williams Co., General Industrial Division, Cleveland 1, Ohio.

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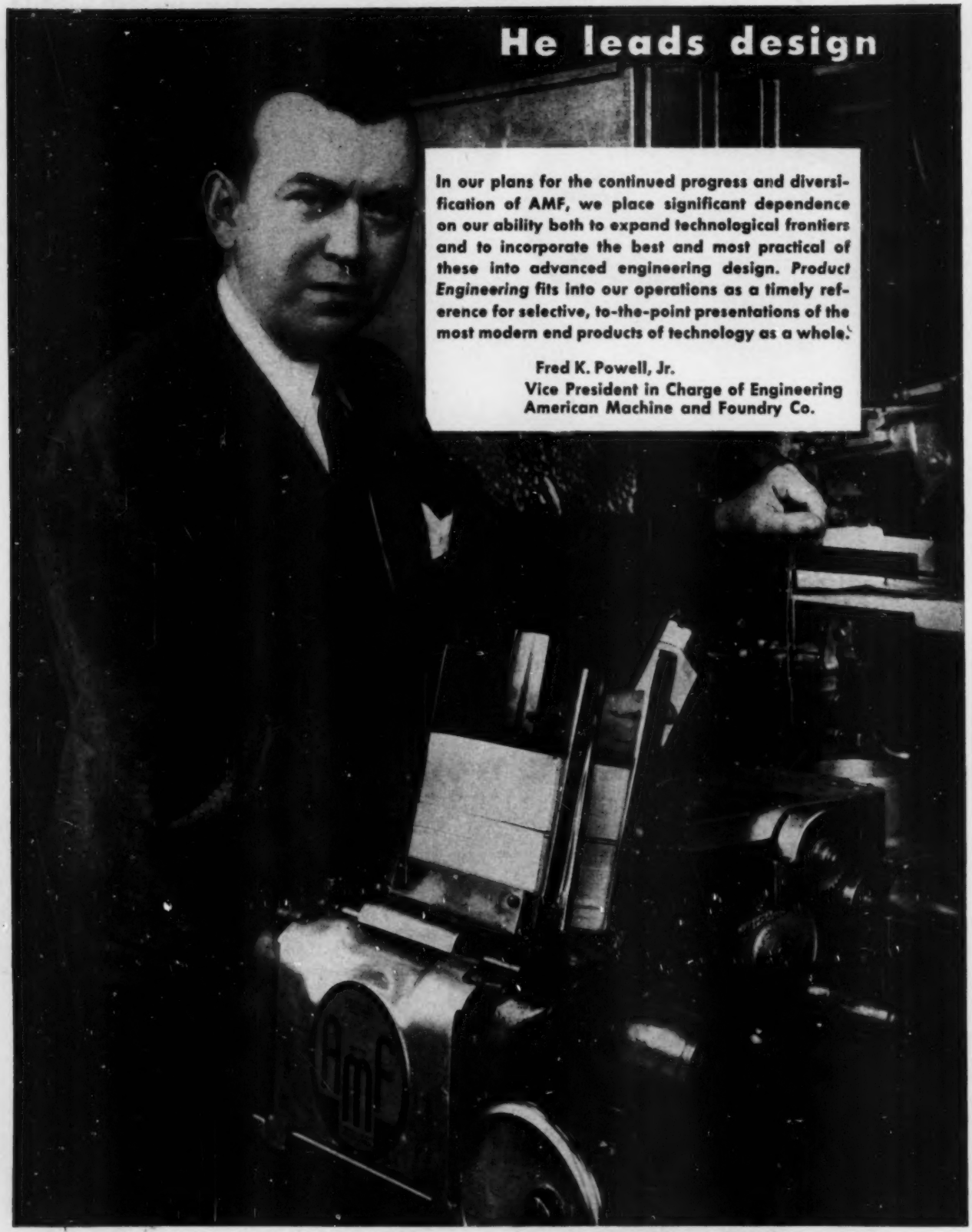
COVER THE EARTH

SHERWIN-WILLIAMS

INDUSTRIAL FINISHES

COVER THE EARTH


He leads design
In our plans for the continued progress and diversification of AMF, we place significant dependence on our ability both to expand technological frontiers and to incorporate the best and most practical of these into advanced engineering design. *Product Engineering* fits into our operations as a timely reference for selective, to-the-point presentations of the most modern end products of technology as a whole.
Fred K. Powell, Jr.
Vice President in Charge of Engineering
American Machine and Foundry Co.

THE MEN WHO DESIGN

at American Machine and Foundry

HE READS PRODUCT ENGINEERING

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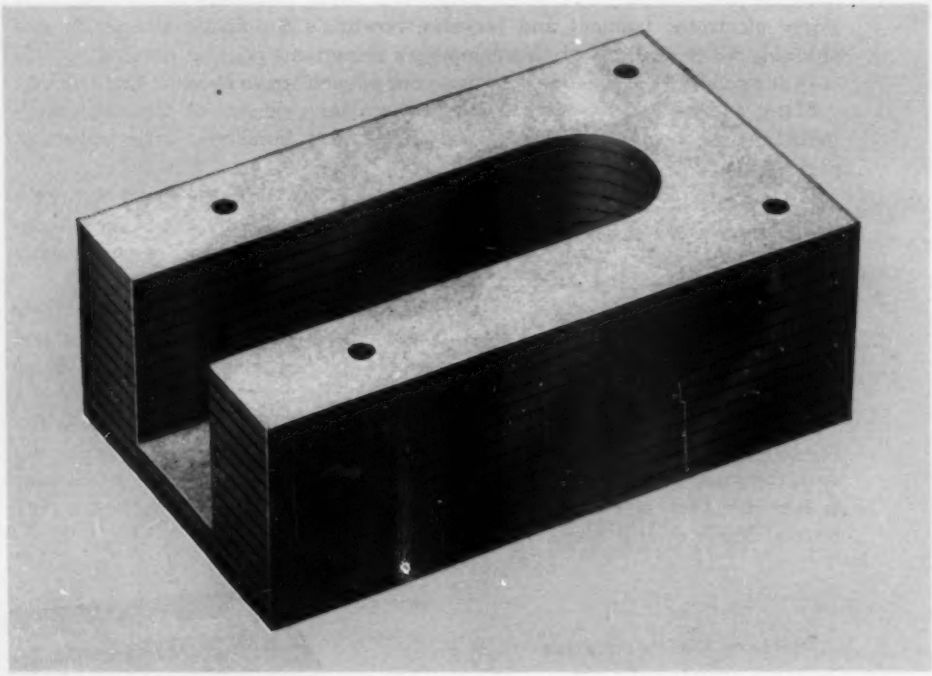
TAYLOR ***Built-up Vulcanized Fibre***
is a new material made of many plies of homogeneous vulcanized fibre bonded together with a special resin developed in Taylor Laboratories. It can be machined with the same facility as homogeneous fibre, has high dielectric strength and is available in any thickness desired. Can be furnished in various colors.

Want to make something of it?

Make it into many products that require physical and electrical qualities that are equal to, or better than, that of the equivalent thickness of homogeneous fibre. The arc resistance at the adhesive line is equal to that of the fibre itself. The adhesive is unaffected by abrupt changes in relative humidity. It gives built-up fibre greater stability . . . resistance to distortion caused by atmospheric conditions. Edge splitting tests have proven the adhesive stronger than the fibre.

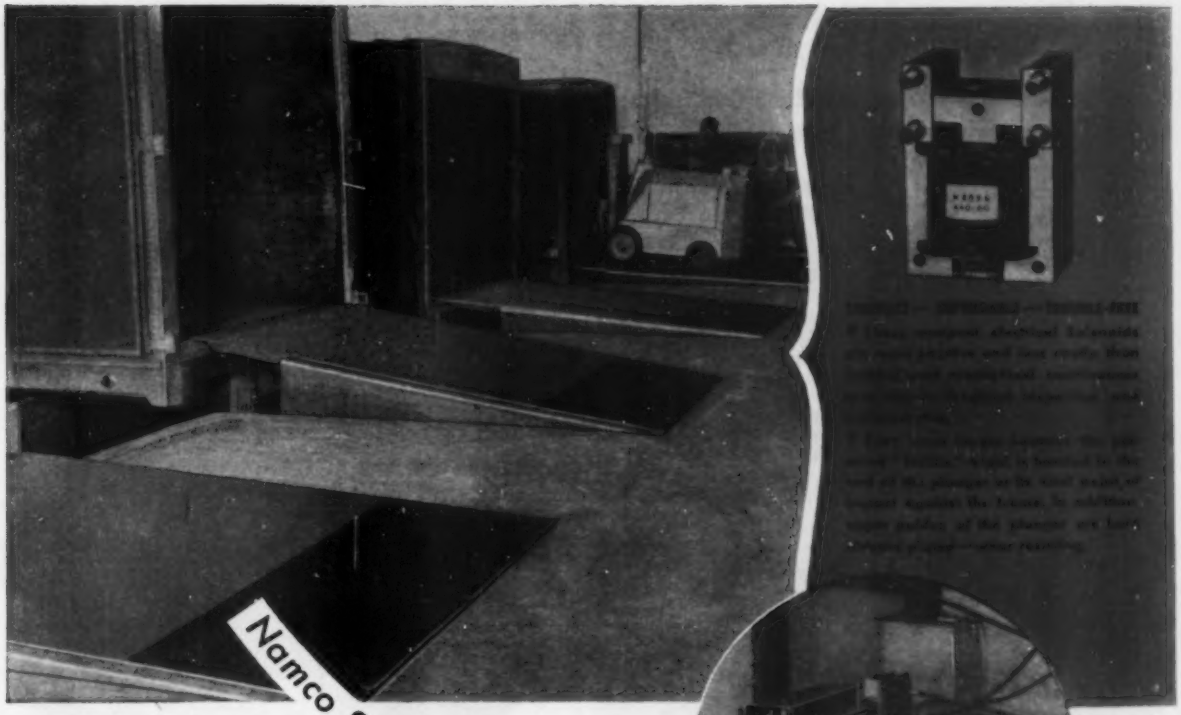


Make it from 45″ x 56″ sheets in any thickness desired. The thickness of individual plies can be varied to suit your particular requirements.

Make sure you get complete information on this versatile new material. Call your Taylor engineer . . . he will be glad to work with you . . . see where it can fit into your products. Let him go over your requirements for laminated plastics also. He may be able to suggest ways that *Taylor Phenol, Melamine and Silicone Laminated Plastics* can do a better job . . . lower your costs.

Taylor Fibre Co., Norristown, Pennsylvania—La Verne, California

TAYLOR
Laminated Plastics
Vulcanized Fibre



Namco Solenoids go underground

to speed multiple dock loadings

Here is a battery of 5 Dock Ramps over which Addressograph-Multigraph Co. Cleveland, move scores of truck loadings in and out each day . . . *"materially reducing waiting time of highway carriers and increasing volume of merchandise handled per man hour"*.

Each ramp is operated by 2 hydraulic rams located in each pit, all of which are remote push button controlled through . . .

Namco "Stellite"-Welded Solenoids

Engineered and built by Beacon Machinery Inc., East St. Louis, Illinois, these 10-ton capacity ramps provide ± 12" vertical and 14" horizontal travel—are automatically leveled.

You select the Namco Solenoid having just the right push or pull capacity you need, mount it in any position desired, then practically forget it so far as servicing is required—dependable!

Namco Solenoids were first built with stamina to satisfy our own hydraulic machine tool needs; they are now standard equipment in 85% of the machine tool industry—many of which are engineered to the job.

* * *

Either AC or DC type solenoids may be specified. Standard ratings range from 2½ to 25 lbs. at 1" stroke. Ask your engineers to talk with ours. Catalog EM-52.

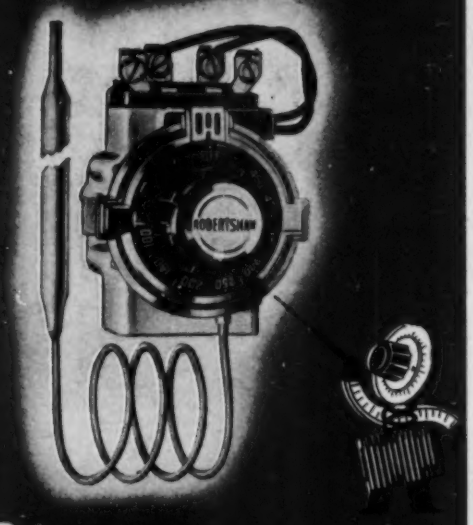
ELECTRICAL MANUFACTURING DIVISION

The NATIONAL ACME CO.

170 East 131st Street • Cleveland 8, Ohio.

ACME-GRIDLEY BAR AND CHUCKING AUTOMATICS, 1-4-6 AND 8-SPINDLE — HYDRAULIC THREAD ROLLING MACHINES — AUTOMATIC THREADING DIES AND TAPS — LIMIT, MOTOR STARTER AND CONTROL STATION SWITCHES — SOLENOIDS — CONTRACT MANUFACTURING

DEPENDABLE



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Heat Control FOR MANY USES

For melting pots for solder, wax, plastics, etc.
For hot water boosters and water heaters.
For urns, fryers, ovens, cooking equipment.
For automatic heat sealing machinery.
For sterilizers and similar applications.
For label dispensers, heating equipment, etc.

Here's a highly sensitive, accurate control ruggedly constructed and designed to meet a wide variety of heating applications with a maximum temperature range of 550° F. It is a double pole, single throw, direct acting control. No separate "off" switch is required. The mechanism is actuated by a hydraulic thermostatic element consisting of a bulb, capillary tube and diaphragm. (Also available in reverse acting types.)

Write for full information.

In Home and Industry EVERYTHING'S UNDER CONTROL

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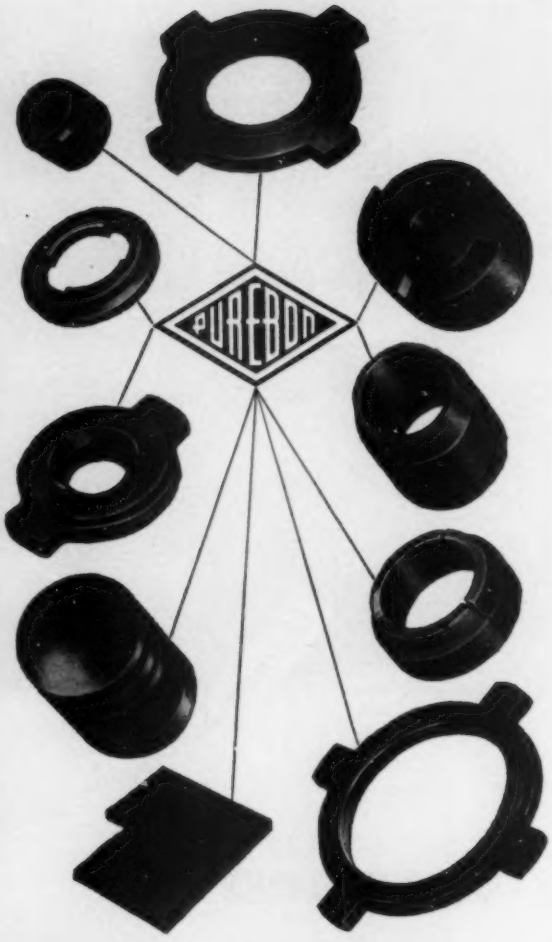
THERMOSTAT DIVISION

ROBERTSHAW-FULTON CONTROLS COMPANY • YOUNGWOOD, PENNSYLVANIA



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SOLVES MANY PROBLEMS
caused by sliding or rotating parts which are DIFFICULT OR IMPOSSIBLE TO LUBRICATE

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Bulletin No. 52 tells the complete story of Purebon. Write for your copy today.

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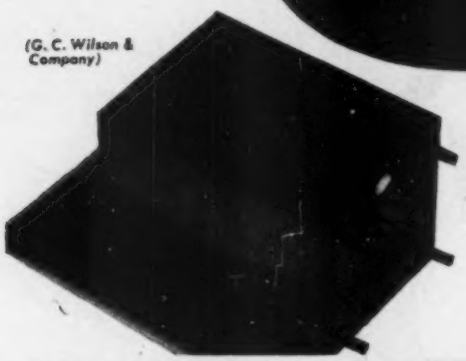
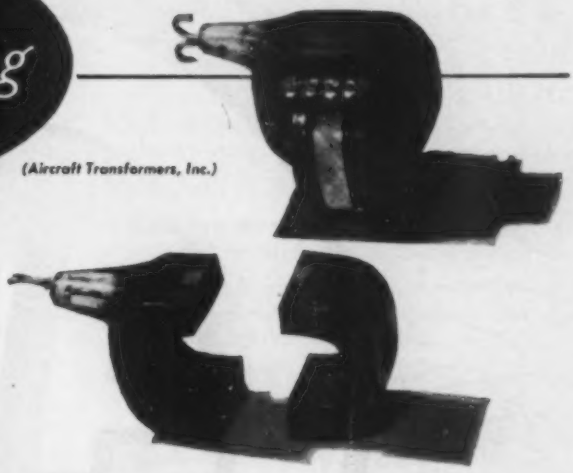
(G. C. Wilson & Company)



ELECTRONIC ASSEMBLY OF AIR-TO-GROUND ROCKET MADE MOISTURE-PROOF AND STRENGTHENED WITH EPOXY COATING RESIN

The time-saving simplicity of coating operations combined with the rugged protection afforded by ARALDITE coating resins make applications such as this routine on either a specialized assembly or mass production basis.

(Aircraft Transformers, Inc.)



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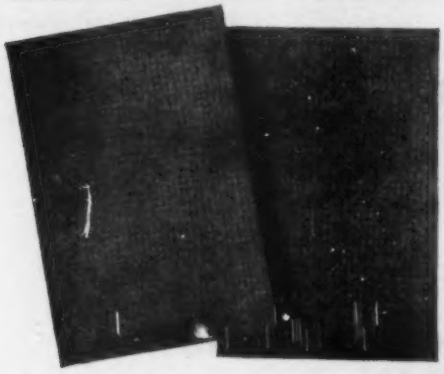
The excellent dielectric properties of ARALDITE epoxy casting resins coupled with high affinity for metals have made them "the resin of choice" among leading electrical and electronic designers and manufacturers for potting and impregnating transformers, capacitators, coils, motor windings and similar apparatus requiring long-lasting efficiency in operation.



EPOXY RESIN PRE-IMPREGNATES GLASS CLOTH

The application of ARALDITE "CN" epoxy impregnating resins by fabricators of glass laminates suggests a wide field of related uses where the low shrinkage, excellent dielectric strength, exceptional resistance to chemical attack and durable adhesive properties provide unprecedented advantages for product "in use" efficiency. ARALDITE impregnating resins are produced in types suitable for either heat-curing or self-curing. ARALDITE is available as pre-impregnated cloth or as cured laminates.

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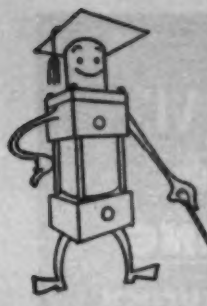

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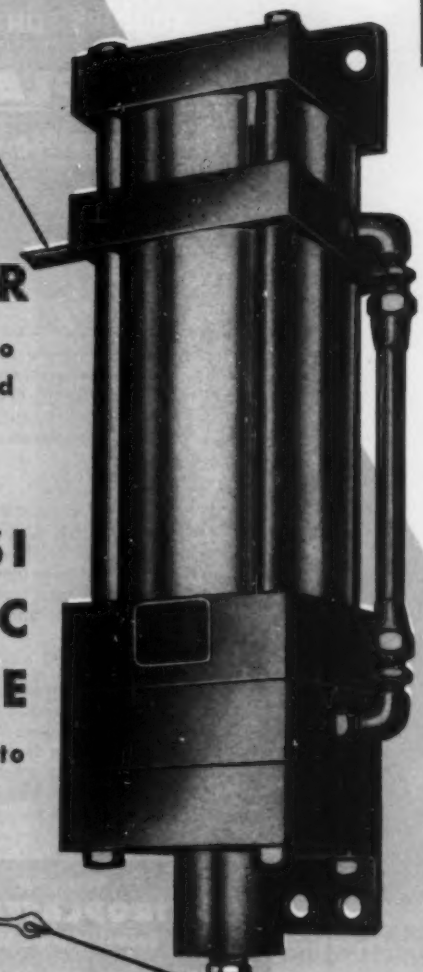

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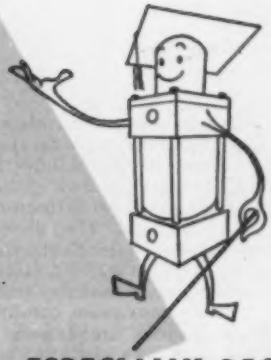

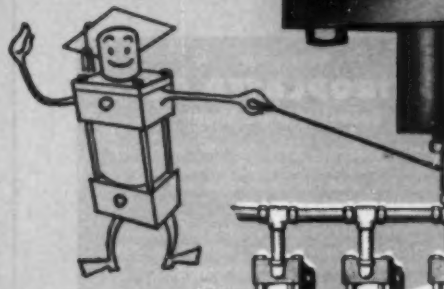

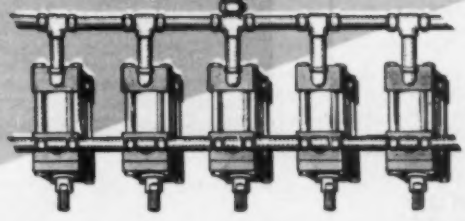

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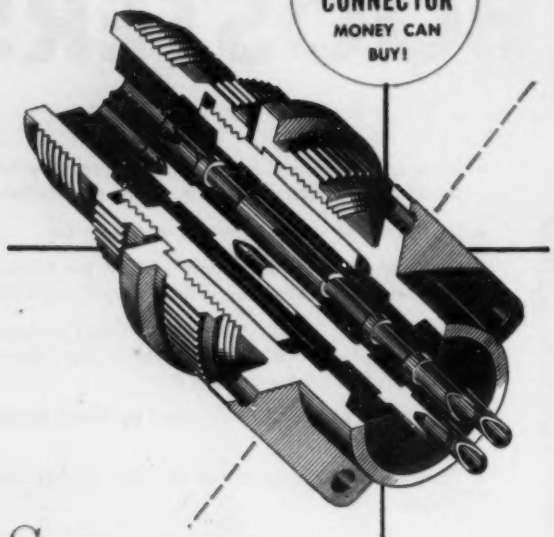

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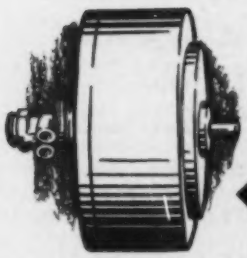

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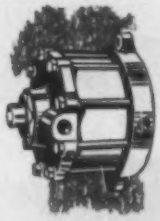

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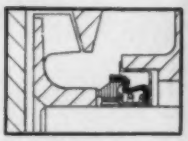
14. Uses only selected rubber stocks.
15. Minimizes cavitation around pump shafts.
16. Permits cooling of rubbing faces.
17. Is a production line item.
18. Is individually tested.

LOW COST



A. Seal Retainer.
B. Synthetic Rubber Bellows.
C. Metal Band.
D. Spring.
E. Holding Dents.
F. Precision-Lapped Sealing Washer.

STATIONARY SEALING HEAD TYPE 11-A

This pressed-in packaged sealing unit is designed to protect the spiral steel spring inside of the synthetic rubber bellows against corrosion.

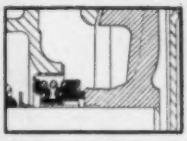
The spring clamps the flange of the bellows tight against the bottom of retainer and the metal ferrule squeezes the top portion of the bellows against the "Teeplelite" washer.

This liquid-tight seal is especially recommended for small shafts on *hot or cold water, oil, gasoline, kerosene, soapy water.*

Use this seal on: *Low Pressures* 35 PSI
Low Temperatures −65°F. to 220°F.

LOW COST

STATIONARY SEALING HEAD TYPE 6-A



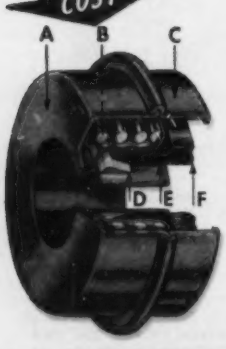
A. Seal Retainer.
B. Metal Ferrules.
C. Spring.
D. Precision-Lapped Sealing Washer.
E. Holding Dents.
F. Synthetic Rubber Bellows.

This pressed-in packaged sealing unit is designed with a spiral steel cadmium plated spring (stainless or bronze optional) assembled between two metal ferrules which clamp the flanges of the synthetic rubber bellows tightly against the retainer shell and the "Teeplelite" washer.

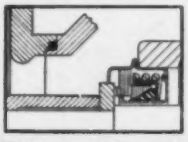
This liquid-tight seal is especially recommended for small shafts on *hot or cold water, oil, gasoline, kerosene, soapy water.*

Use this seal on: *Medium Pressures* 75 PSI
Low Temperatures −65°F. to 220°F.

LOW COST



STATIONARY SEALING HEAD TYPE 9-A



A. Seal Retainer.
B. Spring.
C. Sleeve.
D. Wedge of Teflon.
E. Sealing Washer.
F. Precision-Lapped Face.

This pressed-in packaged sealing unit is designed to use a wedge sealing ring of Teflon*. This wedge shaped sealing ring closely fits the inner sleeve of the retainer and makes a liquid-tight contact with cone surface of carbon washer.

The result is a liquid-tight seal which is especially recommended for *hot oil, and all chemical liquids or gases, hot or cold.*

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High Temperatures 350°F. *Low Temperatures* −100°F.

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*Du Pont Trade-mark for tetrafluoroethylene resin

1. **Compact new packaged units.**
2. **Stationary sealing head, pressed-in type.**
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7. **Minimum friction, cool running.**
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16. **High speed.**

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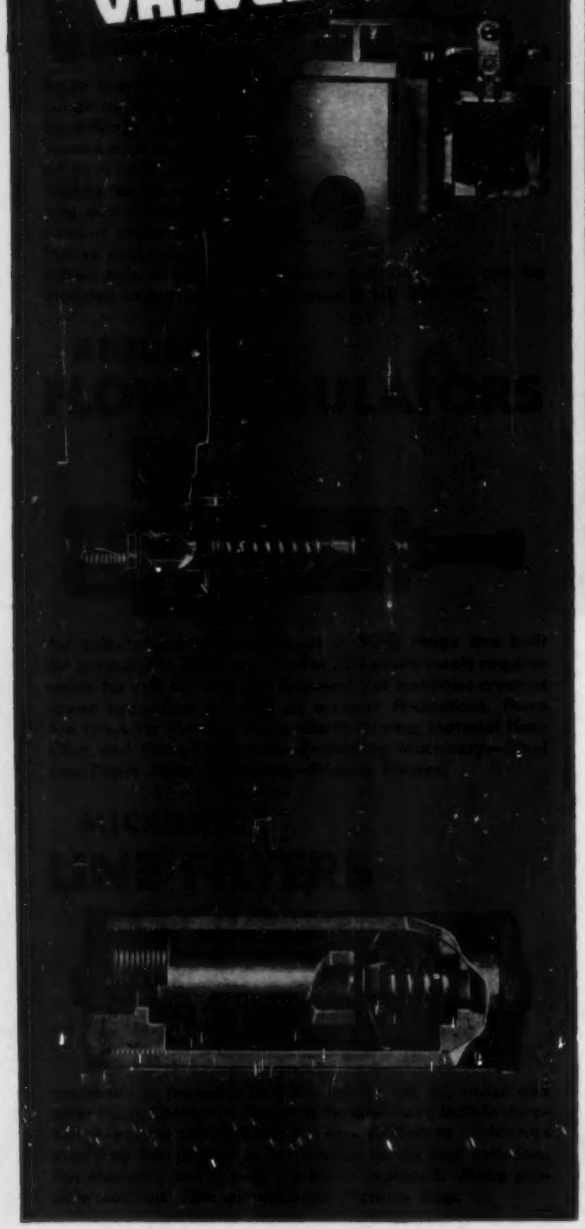

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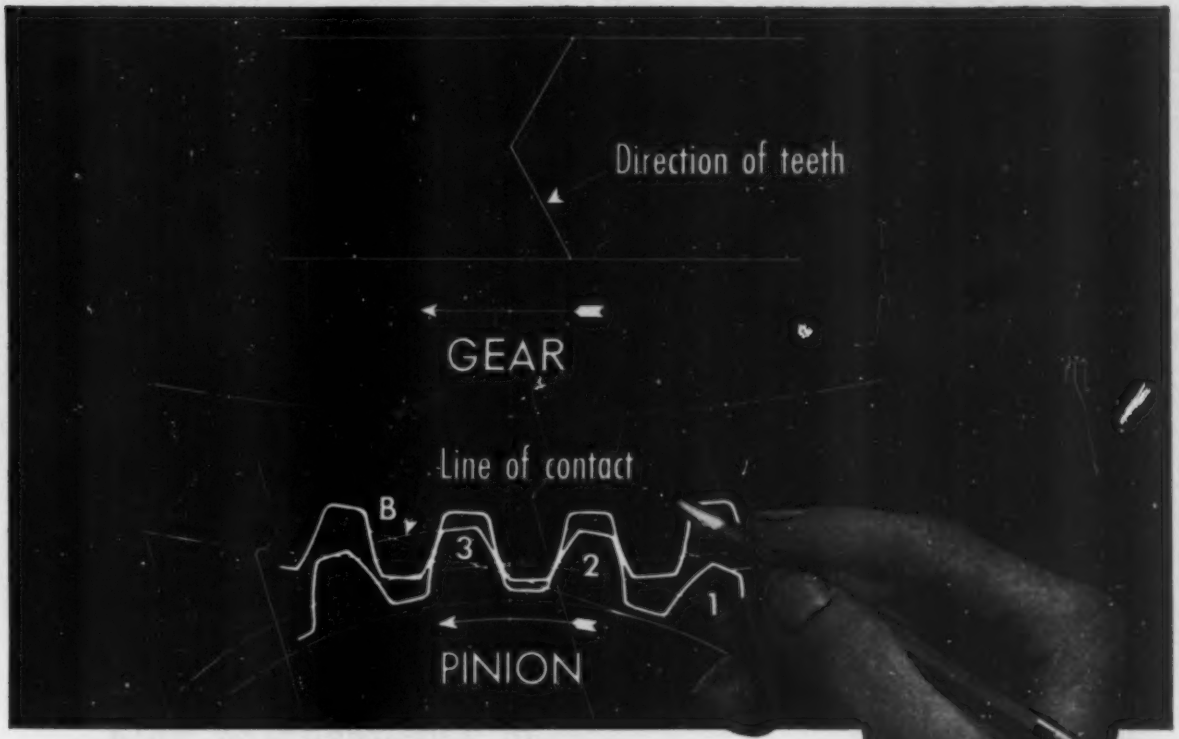

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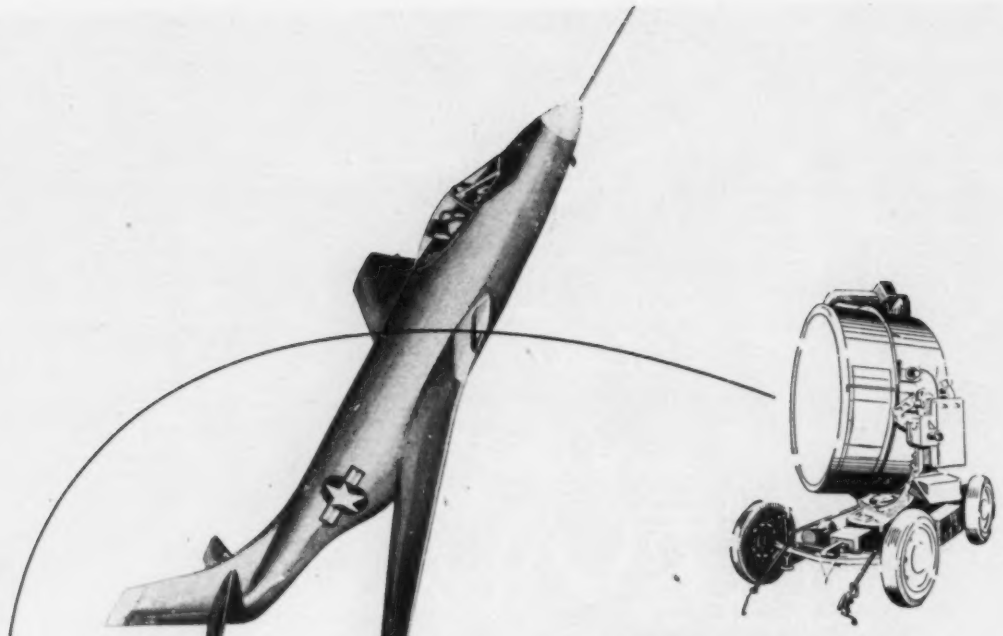

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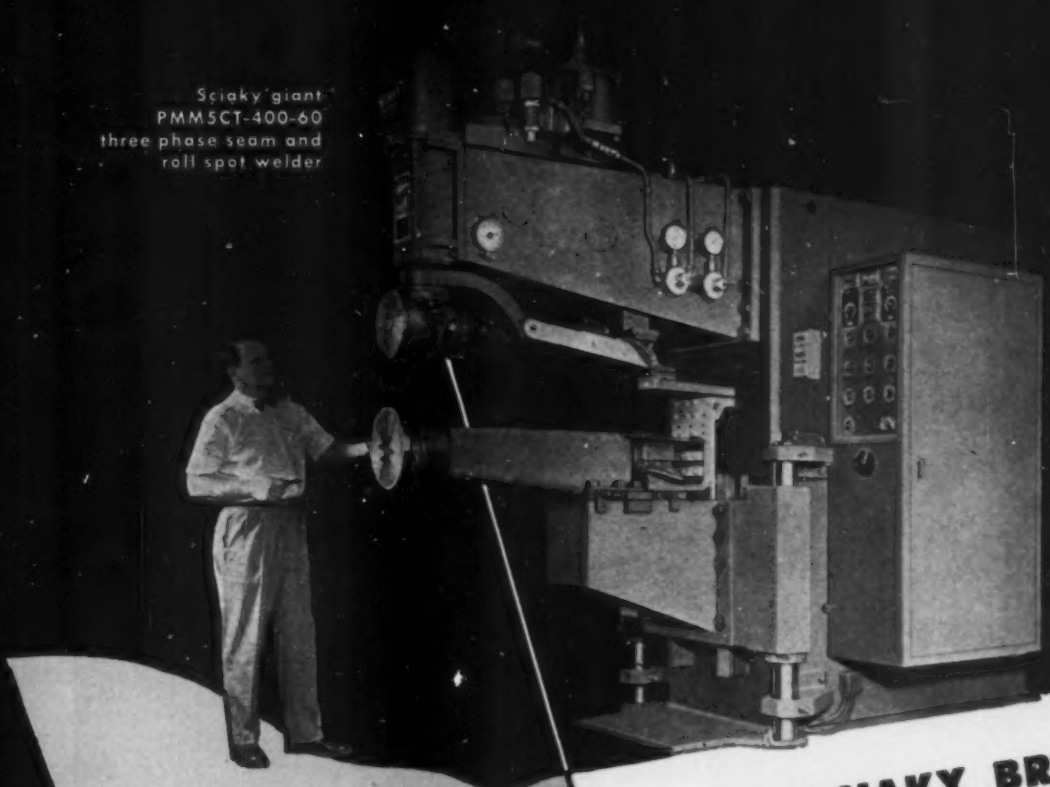
"PERFECTLY ENGINEERED PACKINGS"

LINEAR

LINEAR, Inc., STATE ROAD & LEVICK ST., PHILA. 35, PA.



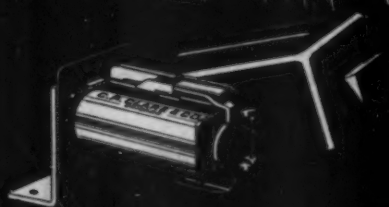
Sciaky giant PMM5CT-400-60 three phase seam and roll spot welder

Where ordinary relays won't do... ...that's where you find CLARE RELAYS

IN SCIAKY BROS. GIANT SEAM WELDERS, for instance

CLARE
Type C Relay

CLARE
Type J Relay



Clare Relays which perform precise functions in control of Sciaky welders are of plug-in type with dust covers

There is nothing small . . . or ordinary . . . about this giant SCIAKY SEAM WELDER. It has a 54" throat depth for longitudinal seam welding . . . a 60" throat depth for circular seam welding . . . and will deliver a maximum of 150,000 amperes of welding current between the electrodes.

Engineers of Sciaky Bros., internationally famous pioneers and inventors of electric resistance welding equipment, found CLARE RELAYS a natural selection for their controls which demand the utmost in precise operation. Among the requirements were:

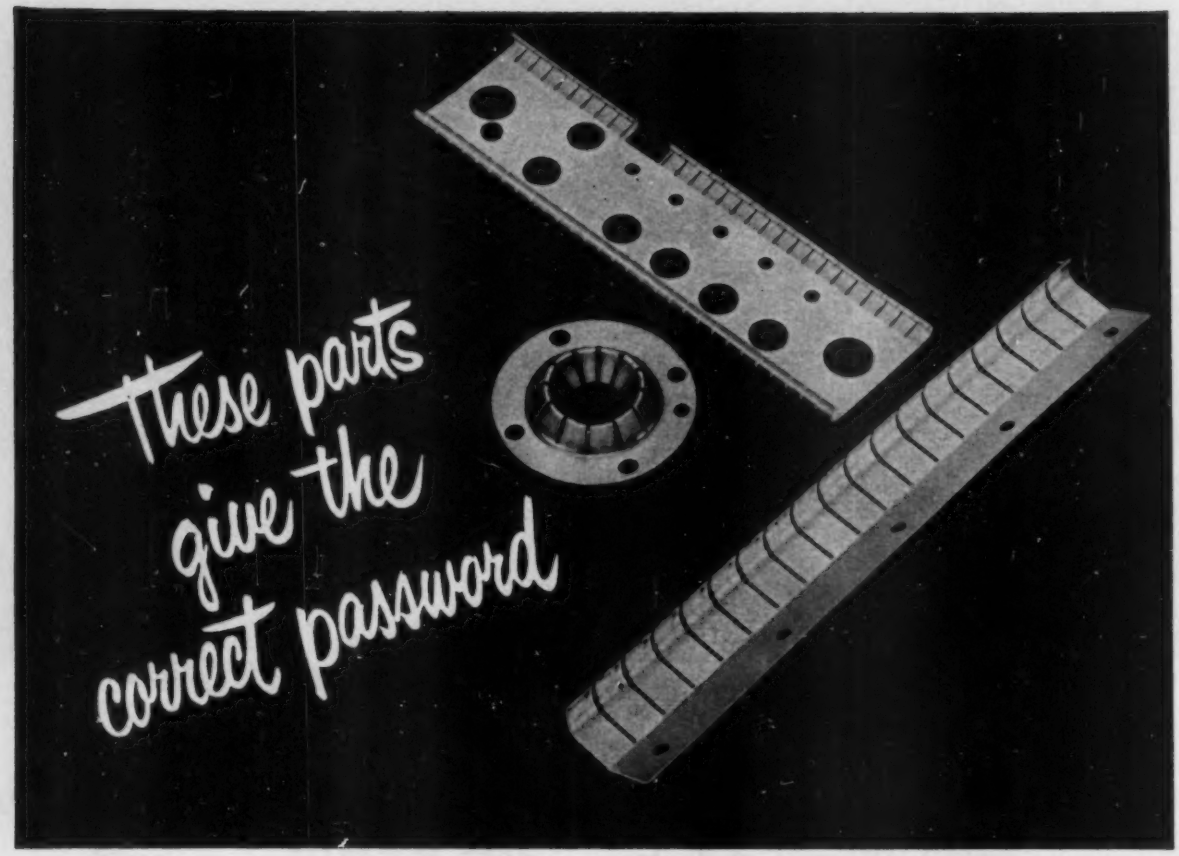
- ★ **Extremely fast operation . . . Within half a cycle, two relays — one operating another — have to be energized and operate their contacts.**
- ★ **Complete structural uniformity . . . Two relays with coils in series must operate their contacts simultaneously and maintain this performance consistently.**

No, this was no job for ordinary relays. Clare Relays were selected and are used for important precision controls in all Sciaky control panels.

If your product, like the Sciaky welder, is a quality product . . . if you must have only the highest quality components . . . a consultation with the engineers of C. P. Clare & Co. can save you time and money. Experienced sales engineers are located in principal cities. Call them direct or write: C. P. Clare & Co., 4719 West Sunnyside Avenue, Chicago 30, Illinois. In Canada: Canadian Line Materials Ltd., Toronto 13. Cable address: CLARELAY.

***FIRST* IN THE INDUSTRIAL FIELD**

CLARE RELAYS



Parts shown processed by H. Braun Tool & Instrument Co., Hawthorne, N.J.

THEY'RE MADE OF BERYLCO BERYLLIUM COPPER

If the IFF radar device used by aircraft should give the wrong signal, our own planes would be in danger of being shot down by antiaircraft and fighter interceptors. Small but vital beryllium copper parts prevent any such catastrophe.

To insure the correct signal, each finger in the circular part must have uniform tension and must line up perfectly. That's one reason why beryllium copper was chosen for this application. The required accuracy can be achieved only by fixture heat treating, and Berylco is the only material that can stand such severe forming and still retain its desirable spring properties.

Of course there are other reasons why this versatile alloy is used here. Its resistance to fatigue, corrosion and relaxation; its electrical conductivity; its indifference to temperature variations—all are important.

The ability of Berylco to offer the designer more than one desirable property has materially increased its application—for peacetime products as well as those used in defense. If you would like to include Berylco in your plans for the future, we invite you to share the knowledge of the world's largest producer of beryllium copper. Call or write any of the offices listed below for help or sample material.

THE MOST COMPLETE LISTING of available beryllium copper forms is contained in the Berylco *Product Directory*, just published. Send for your free copy today.

TOMORROW'S PRODUCTS ARE PLANNED TODAY—WITH BERYLCO BERYLLIUM COPPER

BERYLCO THE BERYLLIUM CORPORATION

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New York • Springfield, Mass. • Rochester, N.Y. • Philadelphia • Cleveland • Dayton • Detroit • Chicago • Minneapolis • Seattle • San Francisco • Los Angeles

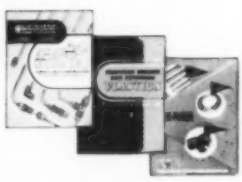
Representatives in principal world-trade centers

Molded right for writing

Our molding assignment for these Alexander pencils was to produce writing instruments properly balanced—smooth of line. Color specifications were carefully met—functional needs of the product were painstakingly watched.

This careful consideration of functional needs characterizes our production activity. First we determine whether or not plastics can do the best job for you. Then we make sure *in advance*, that the plastic material used will be *right* for your product. Our engineers and molders now go to work and create a plastic product that is *right* every way you look at it. *Right* for appearance—*right* for stability—*right* for sales appeal.

We'd like to convince you in person that ours is the *right* molding service for you. Tell us about your plastic problems. You'll receive a speedy and, we believe, a helpful and profitable answer.



Write on your letterhead for the new Injection Molded and Extruded Plastics Catalog. Or, for detailed information about MILLS PLASTIC* pipe, tubing and fittings, write for circulars containing data and illustrations

*Trade Mark Reg

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INJECTION MOLDED and Extruded Thermo-Plastic Materials Including Cellulose Acetate, Cellulose Acetate Butyrate, Acrylates, Methacrylates, Styrenes, Vinyls, Vinylidene Chloride, Polyethylene

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FIRST QUALITY

western *Felt* guards against product failure...

Felt is not "just felt." There is a vast difference in its uniformity, treatment, manufacture and efficiency. Western Felt, for over fifty-three years has not and will not, depart from its policy of maintaining the highest possible quality in material and manufacture. Its products, wherever they may be employed, are your insurance against product complaints due to a Western Felt component part. Here are just a few of its features that you can always depend on: range from wool softness to rock hardness—never loses shape—does not ravel or fray—resists oil, water, heat, age, resilient, flexible, compressible—may be cut to extremely close tolerances for small parts—unsurpassed in uniformity.

Western Felt engineers with decades of experience in the use of felt stand ready to counsel you.

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MANUFACTURERS AND CUTTERS OF WOOL FELTS

Sheet and roll felt manufactured for special purposes and to meet all S.A.E. and military specifications.

Formbrite's superfine finish eliminated buffing on these parts

For the temple bow illustrated, Sunware Products Inc., New Britain, Connecticut, makers of Rayex Sun Glasses, formerly used ordinary drawing brass and finished this part by hand buffing—one at a time.

This was a costly procedure, so a switch was made to Formbrite* . . . then a happy thought occurred:

With Formbrite's superfine grain structure and added surface hardness, why not *tumble* these bows—by the thousands.

It was as simple as that. Formbrite's clean, smooth surface produced a jewelry finish—ready for gold-plating and lacquering. Since these bows are produced by the millions, the savings effected were substantial.

Formbrite, just in case you haven't heard, is a superior drawing brass. Comparative tests prove conclusively that the superfine grain structure of this specially processed forming brass means stamped and formed products that are stronger, harder, "springier" and more scratch-resistant. Yet the metal is so ductile that it can be readily formed, drawn and embossed.

Time studies made of finishing operations have shown that a bright, lustrous finish ordinarily can be obtained by a simple "color buffing" operation—or by tumbling, if the product lends itself to this method.

And yet, Formbrite costs no more. Convince yourself that Formbrite is the metal for your product. Write for Publication B-39. Address The American Brass Company, General Offices, Waterbury 20, Conn. In Canada: Anaconda American Brass Limited, New Toronto, Ontario.

*Reg. U. S. Pat. Off.

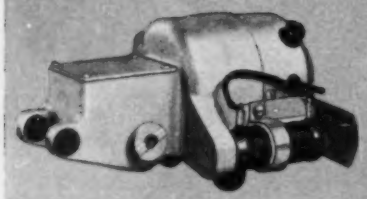
Formbrite

an ANACONDA® Product made by The American Brass Company

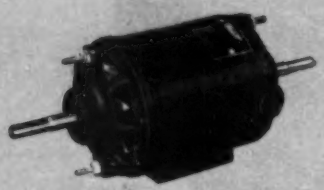
You Benefit from with a...

Lamb Electric

SPECIAL APPLICATION FRACTIONAL HORSEPOWER MOTOR



Series universal motor with inbuilt gear reduction and drive shaft at right angles to armature shaft.



Lightweight universal motor for portable devices requiring a self-ventilated, high-speed motor.

Universal motor with shaft carried on double row ball bearings; developed for use as a high-speed grinder.

You depend on your engineering department to design the products you sell.

With the same confidence you can depend on our engineering department to design electric motors to meet your exact mechanical and electrical requirements.

Your engineers and ours working together can develop a product that will be outstanding in performance, dependability and appearance.

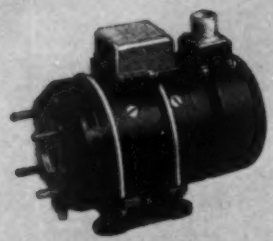
To obtain the maximum benefits from this teamwork we should get together while your product is still in the design stage.

THE LAMB ELECTRIC COMPANY
KENT, OHIO

In Canada: Lamb Electric—Division of Sangamo Company Ltd.—Leaside, Ontario

They're Going Into America's Finest Products

Shaded pole motor for hair dryers; adaptable to other fan applications.



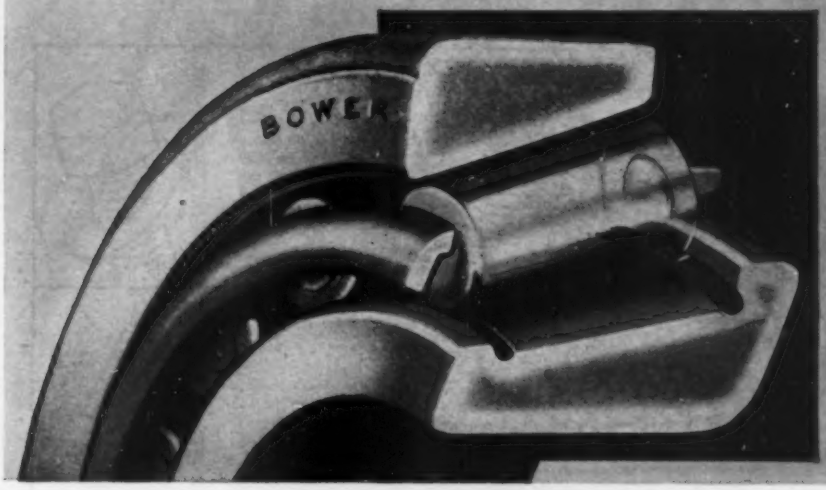
Aircraft hydraulic pump motor with maximum output, minimum weight. Adaptable to many heavy-duty industrial applications.

Series universal motor parts for portable business machines and many types of household appliances.

Lamb Electric

SPECIAL APPLICATION FRACTIONAL HORSEPOWER **MOTORS**

Bower spher-o-honed design provides better bearing lubrication



LARGE OIL GROOVE GIVES POSITIVE LUBRICATION TO ROLLER HEADS

The large oil groove built into Bower Spher-O-Honed bearings is just *one* of several important Bower design features which reduce maintenance and increase efficiency. Combine it with generated spherical roll-heads and a higher flange surface, and smooth, precision-honed races, and you have the basic elements of Spher-O-Honed design.

A careful look at the illustration above will show you other important Bower features, too. Note particularly that the roller heads contact the flange over a wide two-zone area—thus reducing wear and minimizing resultant "end play."

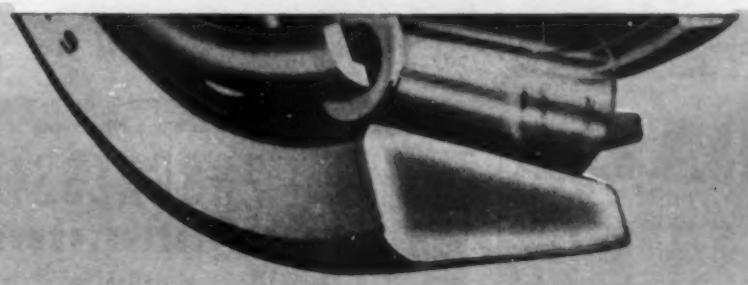
Built of the highest quality materials and workmanship, Bower bearings are available in a complete range of sizes and types to meet your present requirements. Call in a Bower engineer now!

BOWER ROLLER BEARING COMPANY • DETROIT 14, MICHIGAN

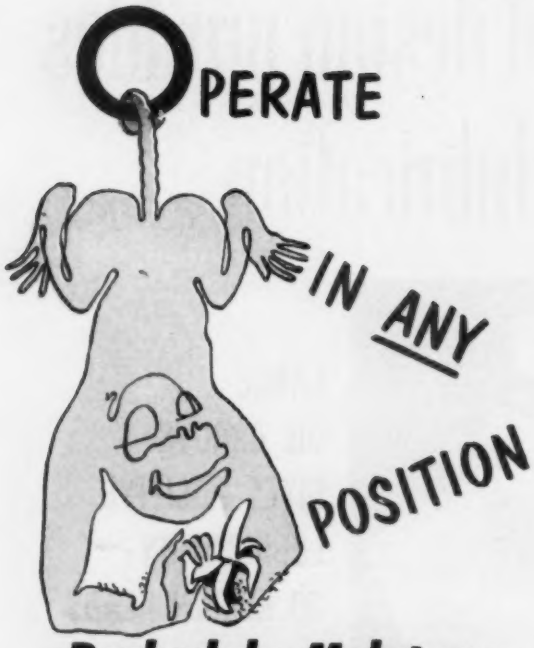
BOWER

ROLLER BEARINGS

SPHER-O-HONED



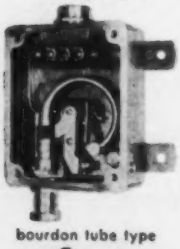
A COMPLETE LINE OF TAPERED, STRAIGHT AND JOURNAL ROLLER BEARINGS



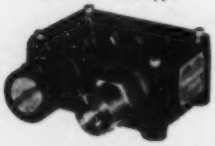
Barksdale-Meletron

PRESSURE SWITCHES

diaphragm type



bourdon tube type



piston type

have extreme repetitive accuracy, are not affected by vibration. Explosion-proof models available.

Diaphragm type sensing elements for vacuum and low pressure (to 120 psi), bourdon tube type for high pressure (to 12,000 psi), and piston type for high cycling rate (to 15,000 psi).

Wherever a Vacuum or Pressure change must initiate electrical action there is a Meletron or Barksdale Pressure Switch to perform that function.

For complete technical information see our catalog in Sweet's 1953 File for Product Designers and in the Plant Engineer's File, or write for catalog 2M-S

BARKSDALE VALVES

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MORE WAYS TO

SQUEEZE PENNIES

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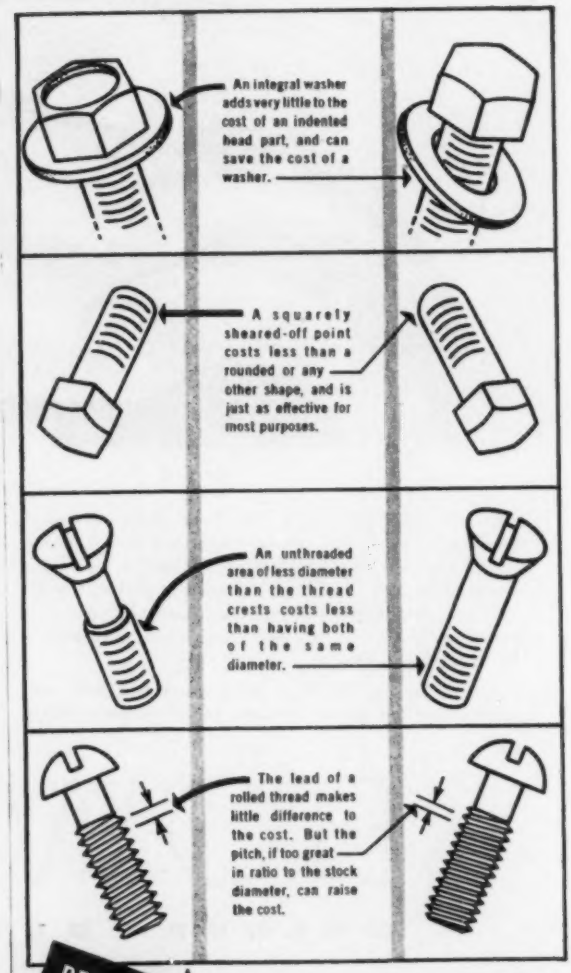
An integral washer adds very little to the cost of an indented head part, and can save the cost of a washer.
A squarely sheared-off point costs less than a rounded or any other shape, and is just as effective for most purposes.
An unthreaded area of less diameter than the thread crests costs less than having both of the same diameter.
The lead of a rolled thread makes little difference to the cost. But the pitch, if too great in ratio to the stock diameter, can raise the cost.

REPRINTS *of this chart are available on request for use in drafting and purchasing departments.*

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MACHINE SCREWS AND SPECIAL FASTENERS ARE OUR BUSINESS

WRITE FOR OUR CATALOG

THE PROGRESSIVE MANUFACTURING COMPANY

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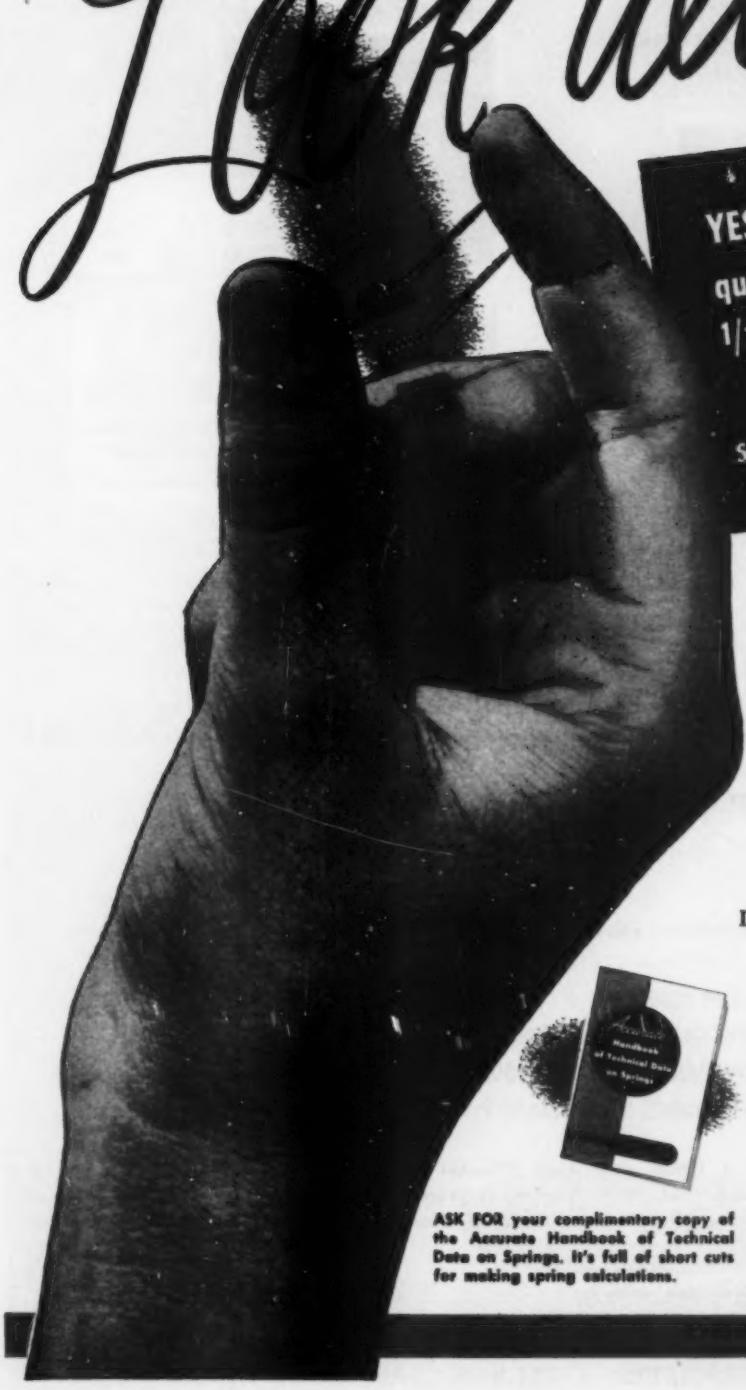
Look alike?



YES... but one is of superior quality and costs less than 1/2 as much because of *Accurate* springmaking know-how!

Given a few machines and some wire, anyone can make springs . . . the difference comes in "know-how." And that's what we have to sell at Accurate.

A good example of how Accurate know-how can pay off is the history of the two springs illustrated above. One was made in two operations and required 100% inspection with rejects running as high as 50%. Accurate know-how developed the means of producing this spring *complete in one operation with such unvarying accuracy that inspection could be eliminated.* First cost is lower . . . overall cost is lower.

If you require precision springs in quantity, we would welcome the opportunity to go over your needs with you and make recommendations. Write today.

ASK FOR your complimentary copy of the Accurate Handbook of Technical Data on Springs. It's full of short cuts for making spring calculations.

ACCURATE SPRING MFG. CO.
3815 West Lake Street
Chicago 24, Illinois

Accurate Springs

Simplify Your Production Methods

Thiokol®

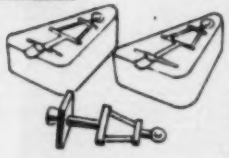
A pourable liquid that converts to a rubber at room temperature WITHOUT SHRINKAGE

Thiokol

PERMANENT FLEXIBLE SEALS

that form tough, resilient bonds with glass, metal, plastics, synthetic rubber, wood and leather.

Sealer made by Minnesota Mining and Manufacturing Company, Detroit, Michigan.



COLD CASTING COMPOUNDS

that conform to exact dimensional shapes of intricate molds and cavities.

Cold casting compound made by Perma-Flex® Mold Company, Columbus, Ohio.

TRANSFORMER COATINGS

that effectively seal against moisture and reduce the weight and volume of the transformers.

Form-Flex® transformer made by Aircraft Transformer Company, Long Branch, New Jersey.

Thiokol Chemical Corporation supplies LP-2 only as a raw material. Because of its desirable properties, it was selected as the elastomer for the applications pictured here.

"Thiokol" LP-2 compounds can easily be flowed into place by pouring or by pressure-feed. They cure to elastomers with the following properties:

TOUGHNESS AND RESILIENCE • HIGH BOND STRENGTH
OIL AND SOLVENT RESISTANCE • MOISTURE AND GAS IMPERMEABILITY
BROAD SERVICE TEMPERATURE RANGE • OZONE, SUNLIGHT AND AGING RESISTANCE
DIMENSIONAL STABILITY

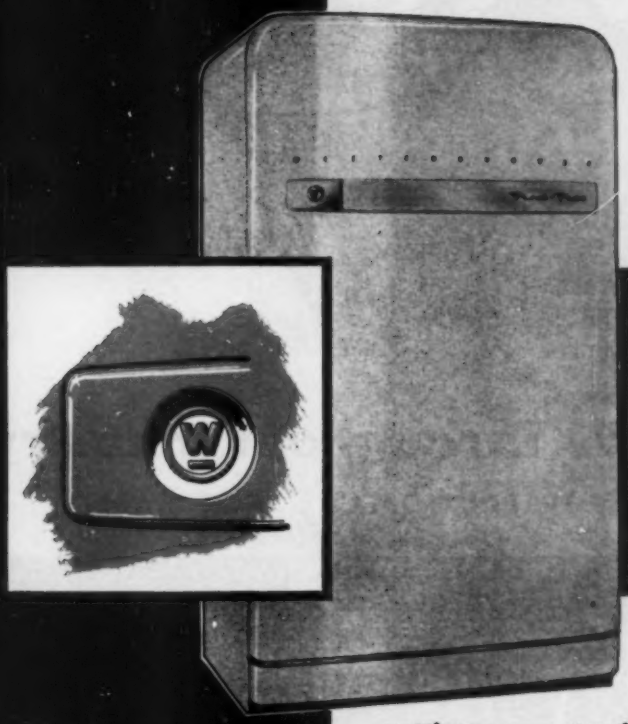
The properties of "Thiokol" LP-2, both as a liquid and as an elastomer, simplify production methods and yield desirable product characteristics in the applications illustrated here. "Thiokol" LP-2 may yield similar advantages in your product or process. Our technical staff will gladly discuss the suitability of "Thiokol" LP-2 for any application you have in mind.

For complete information, write to:

Thiokol CHEMICAL CORPORATION • 784 North Clinton Avenue, Trenton, New Jersey

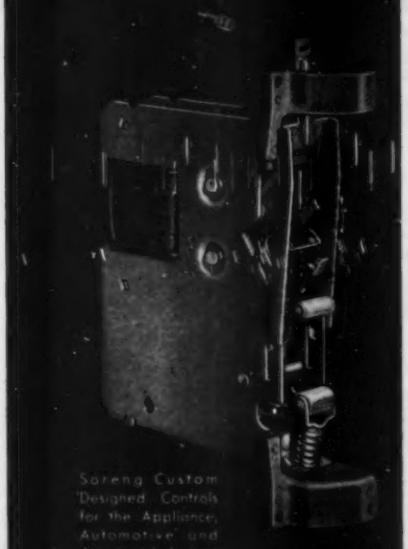
® Reg. U.S. Pat. Off.

from advance-design *Solenoids* by Soreng



comes the new
Westinghouse
Magic

THE SORENG
SOLENOID LATCH



setting a new standard in refrigeration convenience:

This first solenoid latch ever designed is just another example of how Soreng works with industries to help create better and better products. Other refrigerator manufacturers will soon announce models featuring these doors that swing open at a touch—all using Soreng's advance-design solenoids. Soreng specializes in high quality electrical components at production-line prices . . . custom *designed*, custom *engineered*, custom *built* to last the life of the devices on which they're used.

Our engineering service is available to you for the application of Soreng components to your product.

SORENG
PRODUCTS CORPORATION
9563 Soreng Ave., Schiller Park, Ill. (Chicago Suburb)
Plants: Schiller Park, Ill., Fremont, Ohio, Spring Valley, Ill.

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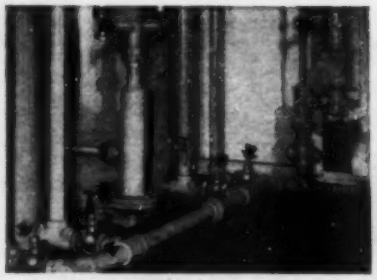
Breaking Records Throughout Industry!

FOR LONG LIFE . . . FOR ECONOMY . . . FOR SAFETY

Leading glass manufacturer reports Rockwood Ball Valves, operated 1500 times a day in a mixing process, were *only valves to stay in service over a year.*



Maintenance engineer of large gas company says: "Easy operation and no maintenance cost make Rockwood Ball Valves *far ahead of any others we have used.*"

On Texas transport firm's fleet of propane-butane trucks, the leakproof construction of Rockwood Ball Valves make them *safest for handling inflammable gases.*

Here's why Rockwood Ball Valves give you more of what you want in valve performance:

FULL ROUND FLOW . . . no change in shape or volume of the fluid stream . . . no turbulence . . . minimum friction loss.

QUICK OPENING AND CLOSING . . . needs only a quarter turn, even under full pressure.

RESISTS WEAR LONGER . . . scratching, pitting and abrasion have little effect on the chrome-plated, floating bronze ball.

STAYS LEAKPROOF . . . in closed position, pressure of fluid automatically positions ball against synthetic rubber seat to form a tight seal.

It will pay you to investigate how these advantages can benefit your own applications. Send for bulletin. Rockwood Sprinkler Company, 106 Harlow Street, Worcester 5, Mass. Distributors in all principal cities.

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Bird Machine Co.
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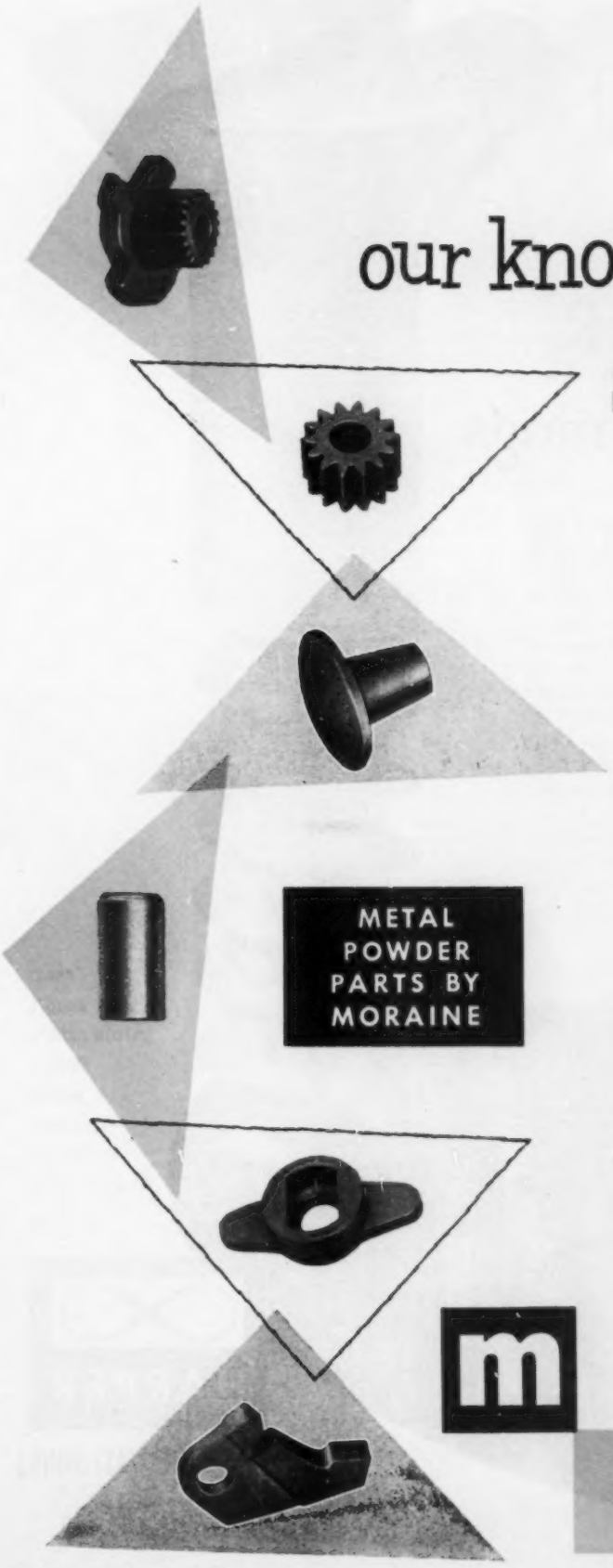
Daggett Chocolate Co.
Also approved by Und. Lab. for L. P. G.

ROCKWOOD *FULL-FLOW* BALL VALVES

THE FLOW IS AS ROUND AS THE PIPE ITSELF



our knowledge began several billion parts ago!

Thirty-two years and several billion parts ago we began learning about powder metallurgy. Our knowledge of this business is now considerable, yet even today there's no end in sight to what can still be learned.

Applying our always-growing knowledge enables us to find new ways to improve the physical properties of our metal powder products; to offer an ever-broadening range of materials to our customers; to make possible more and more applications.

Our position in the field of powder metallurgy is a proud one . . . but we take a greater pride in the fact that our products are providing industry with a means of improving performance while cutting costs.

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DIVISION OF GENERAL MOTORS CORPORATION, DAYTON, OHIO

1½"-18 Flat Head Silicon Bronze Wood Screw. One of 7,000 Stock Items.

end corrosion with HARPER everlasting fastenings

From the day the equipment you manufacture leaves your plant, corrosion begins its work of destruction. It may be slow if atmospheric conditions alone are encountered, or rapid if salt spray, caustic chemicals or acids affect its operation.

Many manufacturers find that the small additional cost of corrosion-resistant fastenings is good insurance on their equipment. Fastenings of brass, silicon bronze, naval bronze, copper, nickel, aluminum, Monel or stainless steel last longer —prevent breakdown—improve appearance and salability.

The H. M. Harper Company is the largest manufacturer specializing in fastenings of corrosion-resistant metals. Over 7,000 items are carried in stock—one order to write—one account to keep—one bill to pay.

There is a Harper Branch office or Distributor near you with stocks ready to fill your order. Consult with Harper metallurgists and engineers on any tough corrosion problem you may be facing.

THE H. M. HARPER COMPANY
8203 Lehigh Avenue, Morton Grove, Illinois

BRASS
NAVAL BRONZE
SILICON BRONZE
MONEL
NICKEL
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COPPER
STAINLESS STEEL

HARPER

EVERLASTING FASTENINGS

SPECIALISTS IN ALL CORROSION-RESISTANT FASTENINGS

EEMCO

technical bulletin

SPECIAL MOTOR FOR *shock* LOADS

This specialized EEMCO motor design employs an in line double spur gear reduction for heavier operating loads or applications where shock loads are experienced, such as air compressors. It is rated at 2½ h.p. for continuous duty, 27 volts D.C. Output speed is 3650 RPM. Unit includes radio noise filter and standard AND 20001 mounting pad and drive.

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3-519

Among other obligations...

When an order is accepted the obligation to supply the commodity as stated in the contract is routine. But every purchaser knows that there are many other and additional services that the seller can render which serve the convenience and interests of the customers.

Along with every order accepted by the Bunting organization is also accepted the obligation to cooperate with the customer as well as to deliver the items as specified.

Ask *any* Bunting customer.

The sleeve bearing is not complex in structure; it conforms readily to design requirements; it is easily installed. Cast Bearing Bronze is the most adaptable of all sleeve bearing materials; it possesses excellent anti-friction properties. With proper film lubrication, its coefficient of friction is as low as can be obtained with any other bearing type. A successful Bunting Bronze bearing installation is readily attainable. We ask the opportunity to work with you, and to quote on your requirements.

Bunting®

BRONZE BEARINGS • PRECISION BRONZE BARS • BUSHINGS

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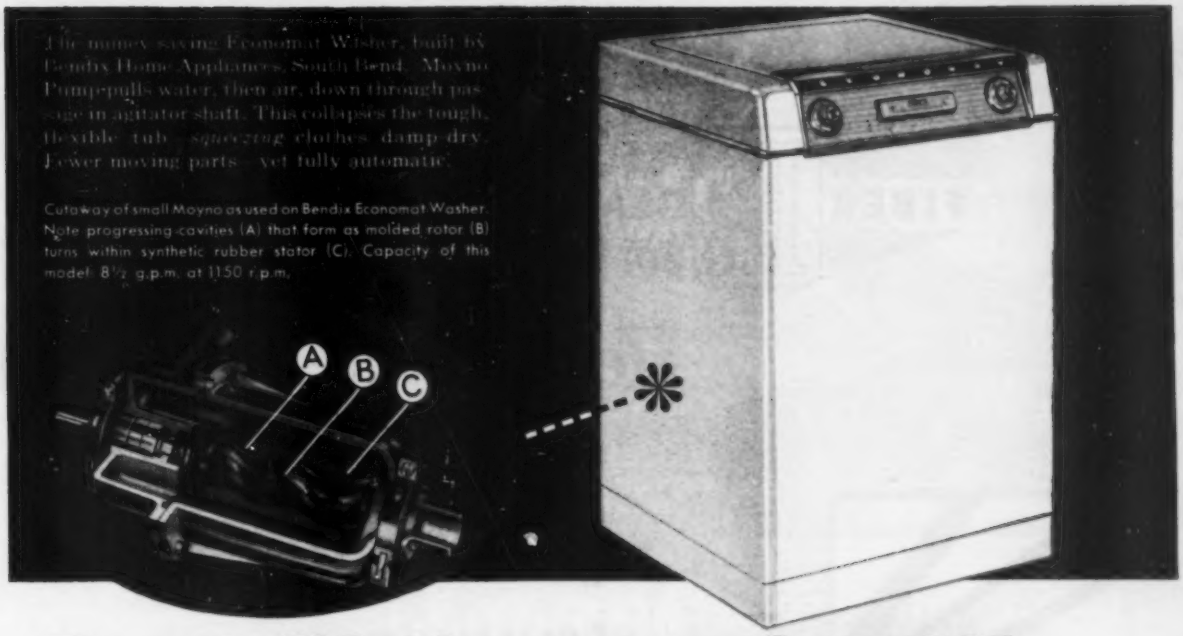
The money-saving Economat Washer, built by Bendix Home Appliances, South Bend. Moyno Pump pulls water, then air, down through passage in agitator shaft. This collapses the tough, flexible tub, squeezing clothes damp-dry. Fewer moving parts, yet fully automatic.
Cutaway of small Moyno as used on Bendix Economat Washer. Note progressing cavities (A) that form as molded rotor (B) turns within synthetic rubber stator (C). Capacity of this model: 8½ g.p.m. at 1150 r.p.m.
A
B
C

Pump life increased 650% in Bendix Economat Washer

with the versatile MOYNO Pump!

An unusual application of interest to builders of products using pumps.

Bendix Home Appliances' answer for a lower-priced fully automatic washer was *fewer moving parts* . . . a flexible tub to contract and *squeeze* clothes dry. Problem: finding an air-water vacuum pump that would do the job.

Bendix tested several different pumps, but none met specifications. The best averaged only 200 cycles before lint, golf tees, buttons and similar foreign particles caused damage and clogging.

But two years ago a completely different pump was first used in production—the R & M Moyno Pump. Specifications required 27" minimum vacuum for a new pump . . . Moynos pulled 28". Specifications allowed a drop to 26" after 1500 cycles . . . Moynos had virtually no drop. In short, Moynos clearly out-performed the other pumps tested, and lasted seven and a half times longer! *Several Moynos still performed well after 3000 cycles . . . equivalent to 10 years of normal washer operation.*

Service? With Moyno Pumps as standard equipment, pump service calls are practically non-existent. Foreign particles don't cause trouble. Lint passes through the Moyno easily, without clogging.

FACTS ABOUT THE MOYNO

the world's simplest pump!

Versatile—Pumps liquid, pastes, abrasive-laden slurries. Adaptable to heavy industrial machinery or small drink dispensers, oil burners, sprayers, etc.

Positive Displacement—Moynos are available to pull up to 29" of vacuum while discharging under pressure. Big Moynos can deliver up to 250 gallons per minute. Pressures up to 600 psi can be obtained. Pumps in either direction!

Gentle—No churning, foaming; won't break up semi-solids. One Moyno is actually pumping potato salad!

Trouble-Free—Self priming; won't cavitate or vapor-lock. Just one moving part—no valves to stick, no pistons to gum up. Low starting and running torque.

Moynos may help improve YOUR product!

If you use pumps, find out about the Moyno—the world's simplest pump! Your application needn't involve vacuum; possibly you need *non-pulsating pressure*. Nor must you take a "standard" Moyno. If necessary, the progressing-cavity principle can be *adapted* to your requirements, as it was so successfully to the Bendix Economat Washer.

Get more facts!

Returning the coupon below will bring you an interesting, factual bulletin on the Moyno Pump—and how it works. It costs nothing to find out if this problem-solving pump can help you . . . mail the coupon today!

ROBBINS & MYERS, INC.

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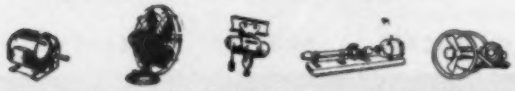

Fractional & Integral h.p. Motors & Generators | Electric Fans | Electric & Hand Hoists & Cranes | Moyno Pumps | Propellair Industrial Ventilating Equipment

Robbins & Myers, Inc., Pump Division, Springfield 99, O.

Gentlemen: Please mail free copy of Bulletin 30-B containing details on construction and operation of Moyno Pumps.

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In addition to fine electrical insulating properties and great strength, fiber glass-based insulations are highly resistant to heat and moisture; to oils and corrosive liquids and vapors; to dust and mechanical vibration. As a result, their use enables many types of electrical apparatus to be of smaller size and lighter weight; and to have substantially longer life.

Pittsburgh Fiber Glass yarns are of such uniform high quality that their use affords advantages for insulating many types of wire and cable, for braided sleeving and tubing, and for weaving cloth for electrical reinforced plastic laminates. Pittsburgh Plate Glass Company, Fiber Glass Division, 420 Fort Duquesne Boulevard, Pittsburgh 22, Pa.

Advantages for manufacturers of electrical insulations

Pittsburgh Fiber Glass yarns are exceptionally uniform in diameter throughout each package. Your inspection and tests are invited. Please contact our Executive Offices or District Sales Offices in Chicago, Cincinnati, Cleveland, Detroit, New York or Washington.

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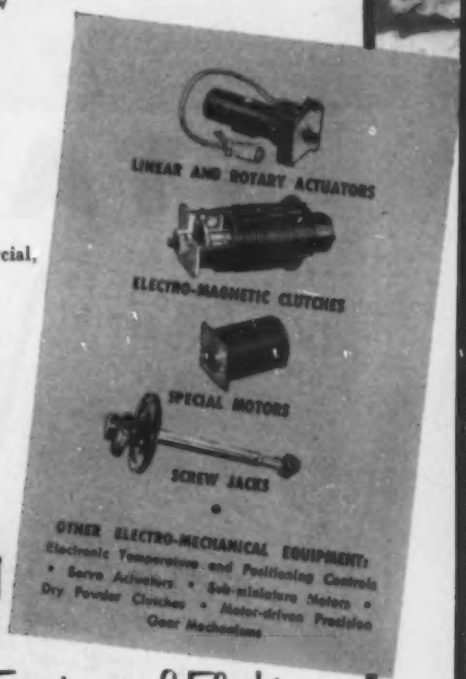
Typical of units designed for the McDonnell F2H-2. Specially developed as a power source, produced to meet specific aircraft requirements.



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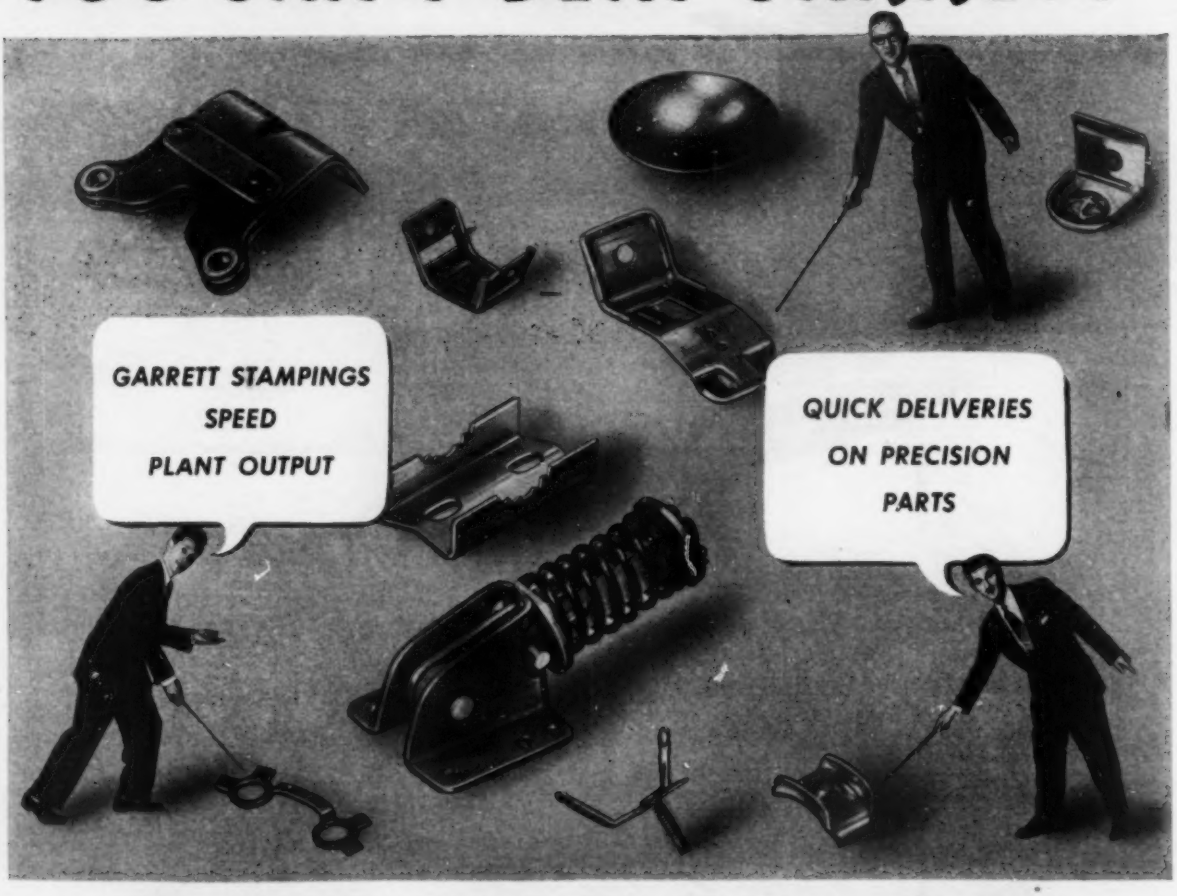

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Save time, trouble and expense by making Garrett your subcontractor on small and medium metal stampings. Garrett has the "know-how" to meet your most rigid specifications. Three modern plants, automatic high-speed presses up to 150-ton capacity, and up-to-date tool shop provide highest quality of workmanship. Finishing equipment includes tumbling, polishing, sand blasting, heat treating and plating.

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FLAT WASHERS Most complete line of washers in the world. To all civilian and Armed Forces specifications.

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If there's any one word that typifies CLARK Drive Units it's "Dependability" . . . the year-in-and-out assurance of smooth, efficient performance even under the most punishing conditions. They're designed specifically for the job . . . soundly engineered . . . built to exacting standards . . . and backed by 50 years of experience. You might find this a good reason to follow the lead of the many manufacturers of heavy duty automotive, farm and industrial equipment who say, "it's good business to do business with CLARK."

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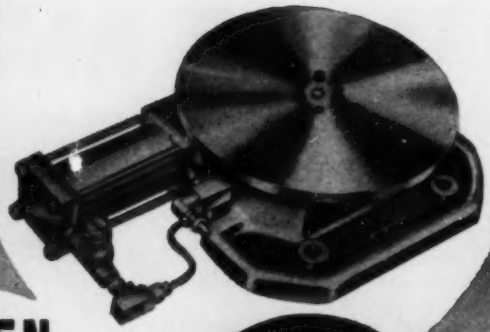

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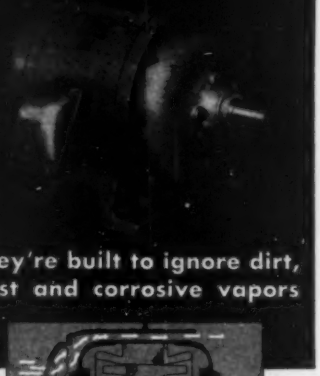
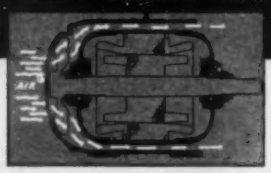
Coto PRECISION WOUND Coils

Let These MOTORS Do Your DIRTY WORK



They're built to ignore dirt, dust and corrosive vapors



SMITHway totally enclosed fan-cooled motor—a frame within a frame and both are cast iron. Efficient, high-capacity, double-locked fan forces air through self-cleaning ducts. Heat is dissipated—dirt, dust and corrosive vapors can't get into the sealed motor.

CAST IRON construction is one of the many outstanding features which makes these motors superior under service conditions involving dirt, dust and corrosion. Cast iron frame, cast iron end bells—the complete enclosure is cast iron—all exposed parts are cast iron. Ideal for petroleum, chemical and other rugged industrial applications.

SMITHway totally enclosed fan-cooled motors are built to standard NEMA frames to meet the highest standards of electrical performance. TEFC motors are built in sizes from 5 to 125 HP. Parts and service available throughout U.S.A. Get complete information from nearest office or write today.

SMITHway totally enclosed non-ventilated motor. Standard NEMA frames. Cast iron construction of all exposed parts keeps these motors, by the thousands, on the job regardless of dust, dirt and corrosive conditions. Available in ratings from 1 to 5 HP.

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Dayton Cog-Belts*

THE PROBLEM: Elimination of vibration on the grinders used to grind threads on jet engine parts. This vibration destroyed the accuracy of these vital threads.

ATTEMPTED SOLUTION: Conventional V-Belts eliminated the vibration difficulty, but belt life was only 1100 hours.

REAL SOLUTION: Dayton Cog-Belts were installed. *On the same machines,* under the same conditions, Cog-Belts ran 5260 hours—nearly five times as long! Performance like that is routine for Dayton Cog-Belts. Their greater flexibility makes them ideal for use over small pulleys. Their stronger *grip* transmits up to 40% more horsepower—lets you save weight and space on drives. Write for all the FACTS about Dayton's complete line of V-Belts, including the famous, exclusive Cog-Belt. Dayton's engineering staff is ready to help you with any drive problem. No obligation, of course. Just write, wire, or phone.

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*T.M.

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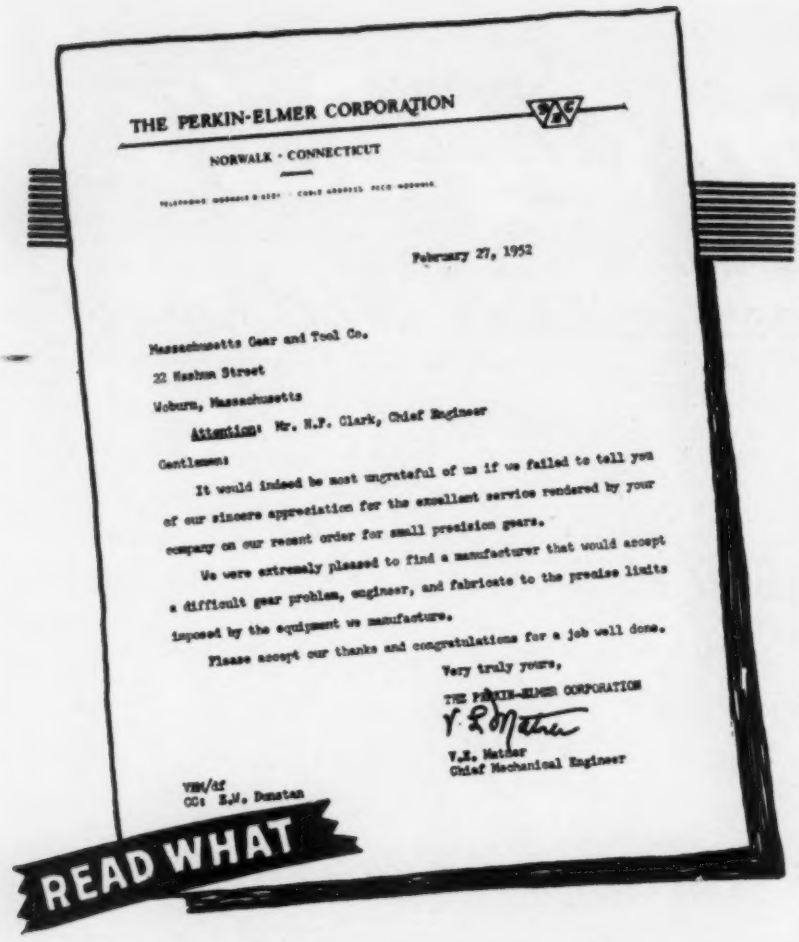
THE PERKIN-ELMER CORPORATION

NORWALK · CONNECTICUT

February 27, 1952

Massachusetts Gear and Tool Co.
22 Hasbrn Street
Woburn, Massachusetts

Attention: Mr. H.F. Clark, Chief Engineer

Gentlemen:

It would indeed be most ungrateful of us if we failed to tell you of our sincere appreciation for the excellent service rendered by your company on our recent order for small precision gears.

We were extremely pleased to find a manufacturer that would accept a difficult gear problem, engineer, and fabricate to the precise limits imposed by the equipment we manufacture.

Please accept our thanks and congratulations for a job well done.

Very truly yours,

THE PERKIN-ELMER CORPORATION

V.E. Mather
Chief Mechanical Engineer

VEM/df
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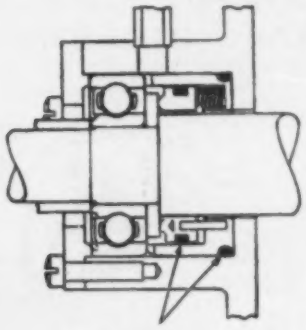
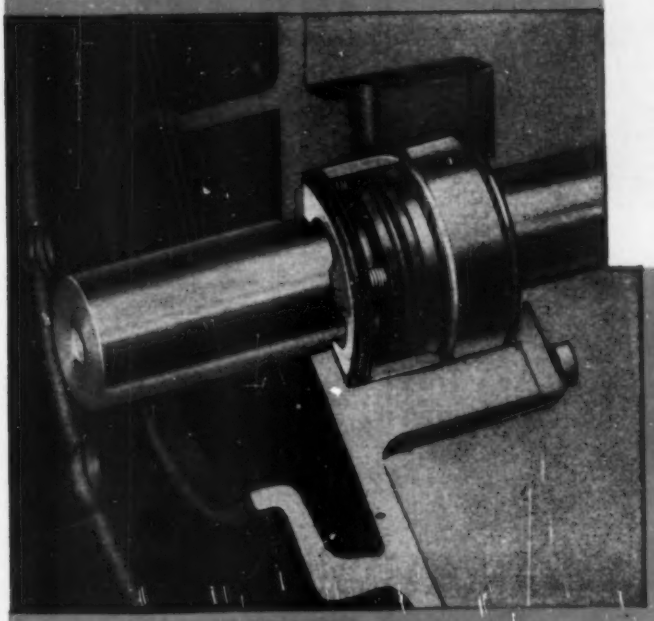
A PAIR OF PRECISION "O" RINGS

makes possible this oil seal's simple design and maintenance-free performance!



"O" RINGS



Two *Precision* "O" Rings are used in the Janette Oil Seal. This simple design is easy to assemble, requires no maintenance, and protects the vital parts of the seal from dust. The performance record of the Janette Seal is unsurpassed. Years of experimentation, lab and field tests went into its development. *Precision* "O" Rings met the tests and got the job!

Everyone is finding *Precision* "O" Rings the best answer to many sealing problems—and they are finding, too, that *Precision* leads the field in engineering help and proper deliveries to keep production lines going. Let us work with you. Send for our "O" Ring Handbook and let us have your inquiries.

FREE—Write for your personal copy of our Handbook on "O" Rings.

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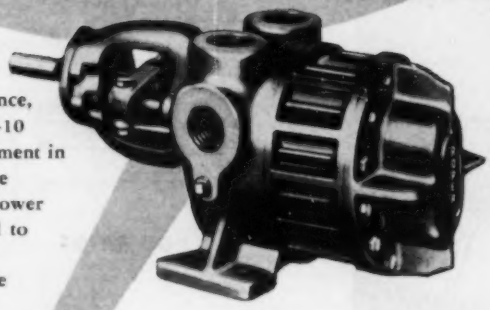
ROPER

SERIES F PUMP...

Integral Part of the Hopkins Volcanic Burner System



Hopkins Volcanic Specialties, Inc., of Alliance, Ohio, uses the Roper F-10 Pump as original equipment in their burner system. The pump, driven off the blower motor, supplies fuel oil to the unit. Hopkins Volcanic Burners, adaptable to any size and design of dryer, are the result of 30 years experience in the combustion engineering field.

FACTS YOU WANT TO KNOW *About the Series F Pump*

★ Series F Pumps available in 1-300 G.P.M. sizes — pressures to 300 P.S.I. FOUR PORT DESIGN — eight optional piping arrangements, 4 CW and 4 CCW rotation, cuts installation time and costs. SLIDER COUPLING — on sizes 1 through 20 G.P.M. permits positive smooth drive and maintains axial hydraulic balance. HELICAL GEARS — of equal size, are heat treated and precision ground. Flange type bronze bearings give ample support to pumping elements. MODEL shown has Packed Box; also made with Mechanical Seal. Relief valve models available.

Send for Catalog 953

Geo. D. Roper Corporation
377 Blackhawk Park Avenue
Rockford, Illinois

ROPER *Rotary Pumps*

STRAIN GAGE TRANS-DUCERS

For Measurement and Control

This 28-page Special Editorial Report from our November 1952 issue will give you the most up-to-date details on strain gages and this design tool's great versatility.

The first of five sections in this special report covers the two classes of gage—bonded and unbonded, types of bridge circuit, amplifying and recording equipment and the systems combining these components. The four remaining sections take up the different types of transducers designed specifically for measuring pressure, flow, weight and displacement. Case histories follow each transducer section to illustrate some of the more unusual applications for strain gage transducers.

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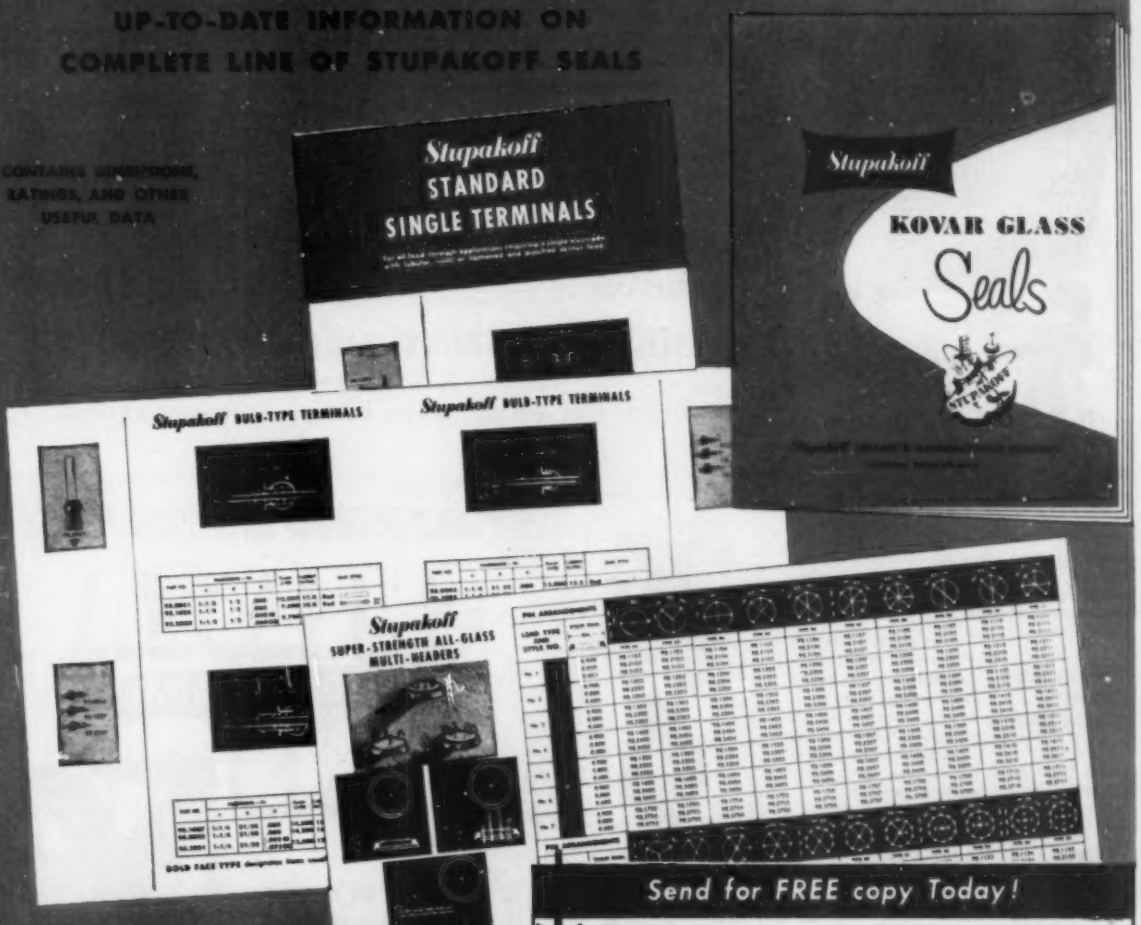
CONTAINS DIMENSIONS, RATINGS, AND OTHER USEFUL DATA



In addition to information on standard and special types of seals, this 32-page catalog has an engineering section with suggestions for manufacturers who wish to develop their own designs.

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The fact that *so many* manufacturers find there are Pheoll stock fasteners that meet exact needs—makes Pheoll stocks the **one source** for you to depend on, too. Our wide range of sizes, metals and finishes simplifies assembly problems; speeds production—because fasteners that fit, make jobs go faster!

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Pheoll rolled threads and cold formed heads provide maximum structural strength to meet stress and strain. Snug thread mating surfaces assure greater contact with more lasting grip—adding life and service to your assembled products.

FINE FINISH IMPROVES YOUR PRODUCT APPEARANCE

The extra fine head and thread finish of Pheoll quality fasteners improves the salability of your product. They help "dress up" the job! You can select from a wide variety of attractive head types in screws for metal, wood and plastics—nuts with single or double chamfer in various metals and finishes.

Write for Additional Information and Price List.

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NUTS

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Thuja occidentalis is a type of *cedar tree* —of which there are many in the landscaping around our modern, attractive plant. What do they have to do with making gears? Indirectly, a lot; because they contribute a lot to making our plant a desirable and attractive place for our expert craftsmen to work. Pleasant surroundings, we believe, are of major importance in helping our employees produce the highest quality work they are capable of. Thus our Thuja occidentalis is one of the many details we've considered in our efforts to bring you better custom gears. If you're not already a Cincinnati Gear customer, inquire today for full information.

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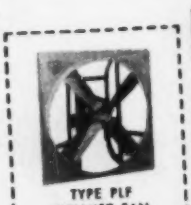
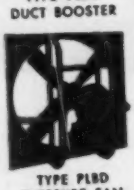


TYPE PLF EXHAUST FAN

TYPE PLDX DUCT BOOSTER



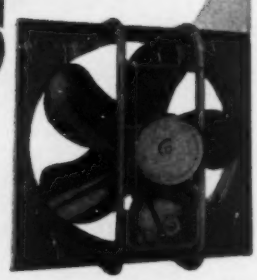
TYPE PLBD PRESSURE FAN

TYPE PLDU AIR BLASTER

WRITE FOR CATALOG 400

FOR HAZARDOUS LOCATIONS USE—

CHELSEA
EXPLOSION-PROOF
FANS

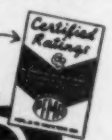


TYPE IND EXHAUST FAN
For factories, mills, theatres, schools, hotels etc. Features belt drive with ball bearing motor. Sizes from 24" to 72".

THE ABC OF SAFETY—
Always Buy Chelsea!

Performance-proven CHELSEA explosion-proof fans meet rigid ventilating and exhaust specifications to the letter. For hazardous locations, specify CHELSEA type fans supplied with Class I, Group D motors, and non-ferrous, non-sparking propellers. Ask CHELSEA for recommendations for your particular processing or industrial need—address Dept. B7.

Look for this Seal of Certified Ratings
Look for this Symbol of Quality



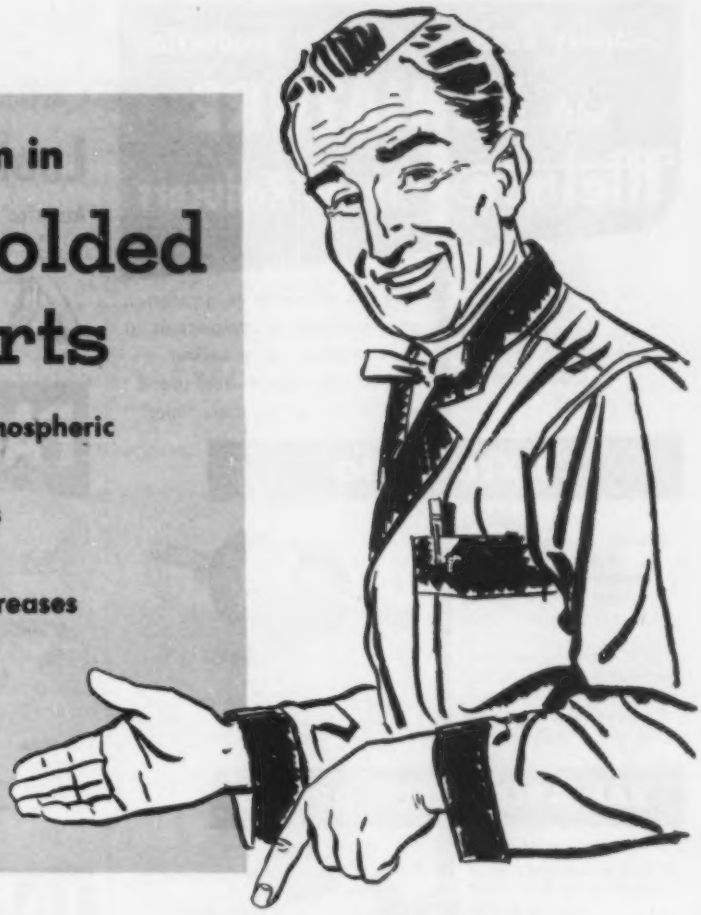
CHELSEA FAN & BLOWER CO., Inc.
PLAINFIELD, NEW JERSEY

If your problem in

Custom Molded Rubber Parts

- is extreme temperature, or atmospheric conditions
- or is service with special fuels and lubricants
- or is service with acids and greases
- or is exacting tolerance specifications

CALL THE PARKER RUBBER ENGINEER



Meeting your requirements for molded rubber parts is a PARKER specialty. Answering your problems is a challenge to the PARKER Rubber Engineer.

If rubber parts must give long and trouble-free service under very difficult operating conditions, PARKER's research and experience may hold the moneysaving answer for you—as it has for many PARKER customers in automotive, electrical equipment and other industries.

EXCLUSIVE NEW TECHNIQUES—Newly perfected high-production processes and molding methods mean lower cost and greater value in finest custom molded rubber parts. Investigate this PARKER service; mail the coupon today!

FOR EXAMPLE:

This **RADAR SCREENER PAD**, (approx. 1¾ long), molded from a fuel-resistant compound, presented an intricate molding problem because of the difficulty of removing the part from the mold.

This **GRAIN SPACER** (approx. 6" in dia.), a typical spacer gasket, which, through perfection of new cost-saving methods and processes, can be produced in large volume in a relatively short time.

This **RADAR GROMMET** (approx. 1⅜" wide), involving a complicated molding problem, but which, again thanks to newly perfected techniques, is handled to the customer's complete satisfaction from both a time and price standpoint.

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Available in volume in three Classifications

You can use ready-to-go Metron speed changing components in your products at a saving in cost and space-and speed production at the same time.

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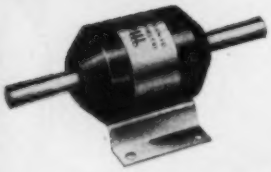
Only 1.050" in diameter, anti-backlash and hobbed gear types, available in STANDARD RATIOS from 10:9 to 531,441:11 Special ratios to 2,000,000:11 Completely enclosed, permanent lubrication, ball bearing input and output shafts. Ask for Bulletin 100.



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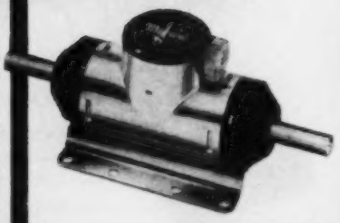
Only 4-5/32" long, smooth and accurate, cover infinitely variable speeds from 1:5 step up through 1:1 to 5:1 step down. Permanent lubrication, plus your choice of 6 adjustment controls. Speeds up to 10,000 RPM, nominal output .025 HP. Ask for Bulletin 99.



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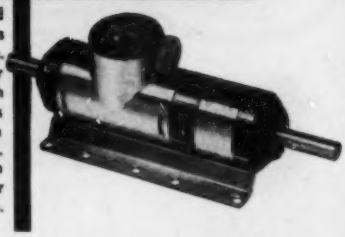

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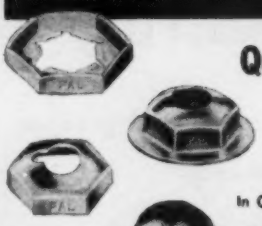

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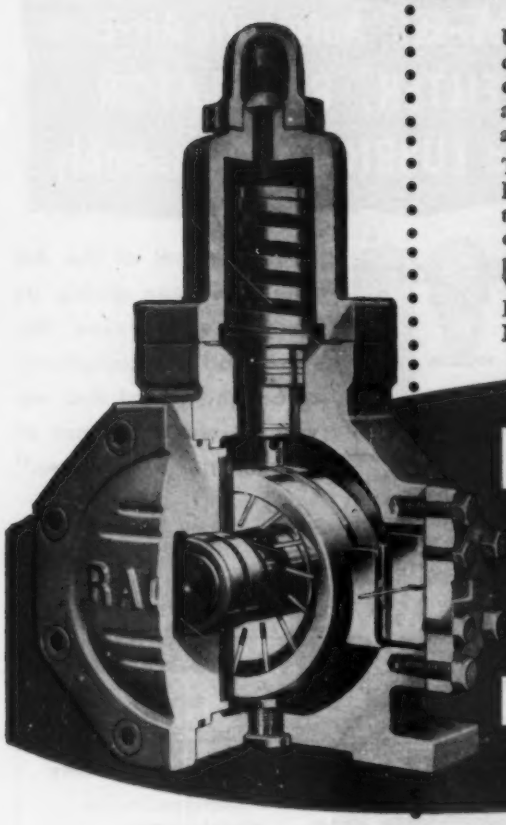
Simplify the Circuit and Improve Its Efficiency



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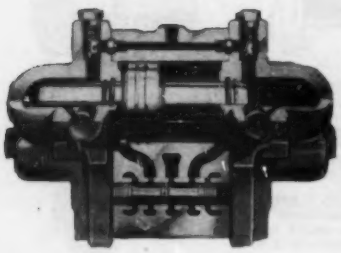
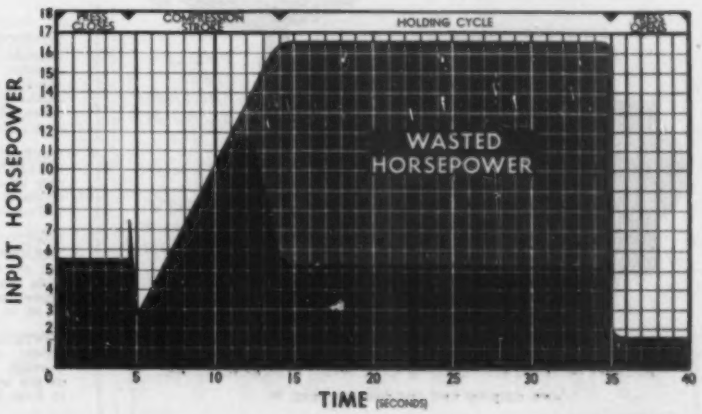
PUMPS

The black area in the chart below shows the H. P. consumed during one complete cycle of operation when a No. 6 RACINE Variable Volume Pump and 7:1 Pressure Booster is used. The red area shows the wasted additional H. P. required when an efficient 2-pressure, 2-volume Constant Volume Pump of equivalent size is used. Note the savings in H. P. Chart is based on the operation of a 200-ton molding press with a 10" ram.



RACINE
Hydraulic BOOSTER

A 7:1 ratio pressure booster was used in the circuit in chart at right. Pump pressure of 725 p.s.i. was increased to 5000 p.s.i. with no increase in H. P. Racine Pressure Boosters are available in 3:1 to 7:1 ratio sizes.



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Operates efficiently at —40° to +140°F. Available with gear trains for any speed.

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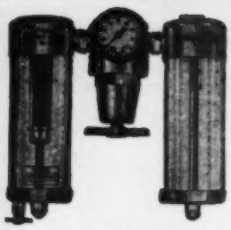
"M-B" Automatic Air Line FILTER, REGULATOR and LUBRICATOR Assembly



The value of "M-B" Automatic Air Line Filters, Regulators and Lubricators is widely known for their effectiveness as a protection to Air Valves, Cylinders, Pneumatic Tools, etc.

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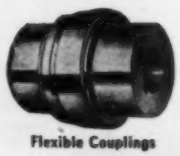

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how can we help you?

Tell It To Titchener

Perhaps Titchener can solve your problem with wire. Send prints —describe requirements in a letter. Confidential. *No charge for our suggestions.*

Conserves sheet steel by substituting wire

This ice cube deflector originally consisted of sheet steel, woven wire and a steel frame. Sheet steel shortage loomed. Told it to Titchener. Titchener designed rack using one size of wire throughout. No sheet steel needed — sturdier — costs less.

Invents fixture to produce complicated design

Manufacturer required this intricate two-piece clamp. Ran into production difficulty. Told it to Titchener. Titchener built a special power-forming fixture which coils wire around itself — thousands of precision-made clamps now produced at high speed, low cost.

Combines motor mount and guard to reduce cost

Manufacturer requested quotation on wire guard to slip over motor mount. Titchener suggested combining guard and mount in a single assembly. This simple one-piece construction slashes material, production and assembly costs.

Replaces casting with welded wire —eliminates breakage

Stove manufacturer experienced high breakage of his cast iron burner grates. Told it to Titchener. Titchener design shown here is lighter — stronger — eliminates breakage — is economically produced.

Send for FREE Handbook

"Use of Wire Construction in Product Design" — an illustrated 20-page technical handbook sent free to engineers, purchasing agents and production men. Write for your copy.

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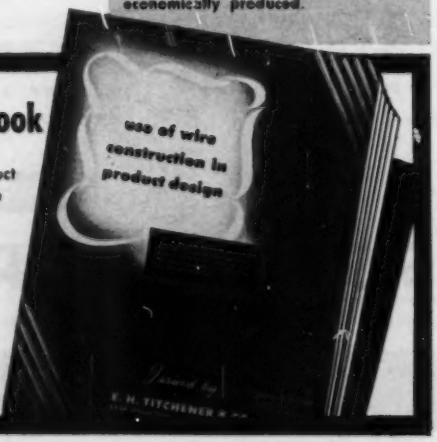

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TEMPERATURE PROBLEMS IN BEARING APPLICATIONS?

If you do, you can find real help on this subject—as on so many others—in your *Annual HANDBOOK of Product Design for 1953.* An important, carefully detailed report in the *HANDBOOK* explains an empirical formula which enables the designer to specify speed, load, and lubrication requirements so that the bearing operating temperature will fall within safe limits.

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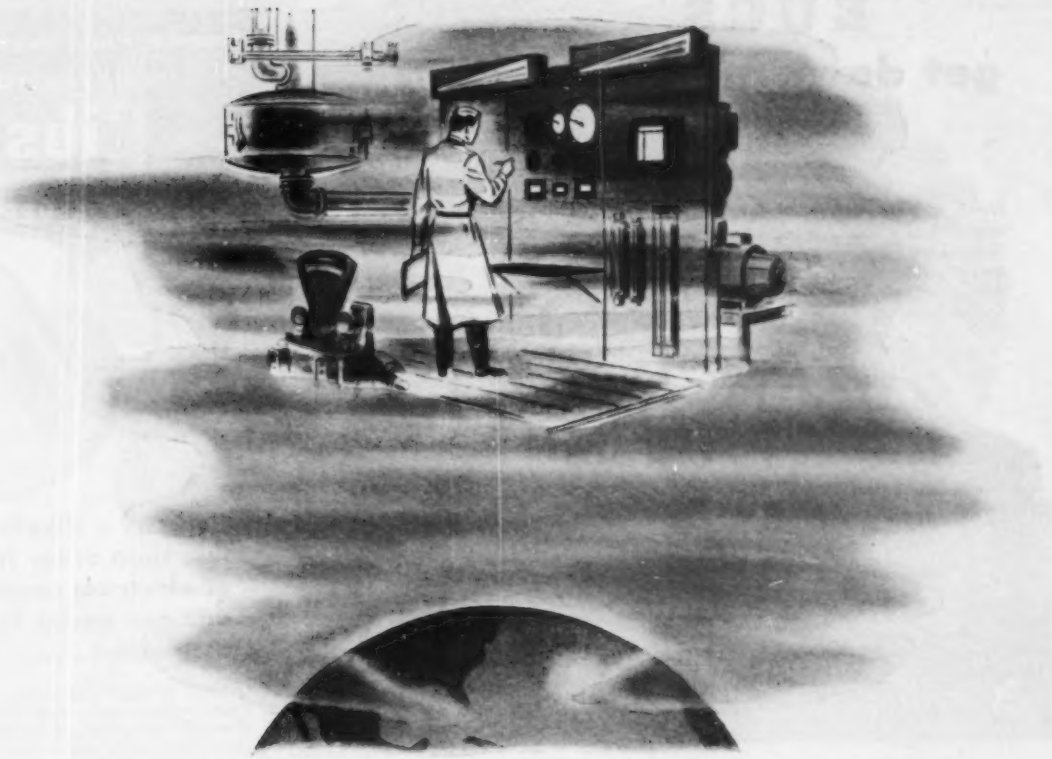

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Or pumps to handle low-boiling-point liquids, (like aviation gasoline), without troublesome vapor-lock or cavitation.

Or pumps to work at 1,000-pound pressure dependably in desert heat *and* Arctic cold.

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DEPT. AE-7 • CLEVELAND 17, OHIO

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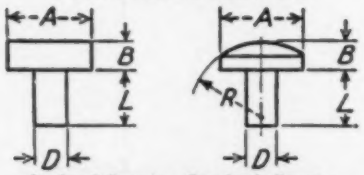

A = head diameter D = shank diameter
B = head thickness L = shank length
R = radius of face

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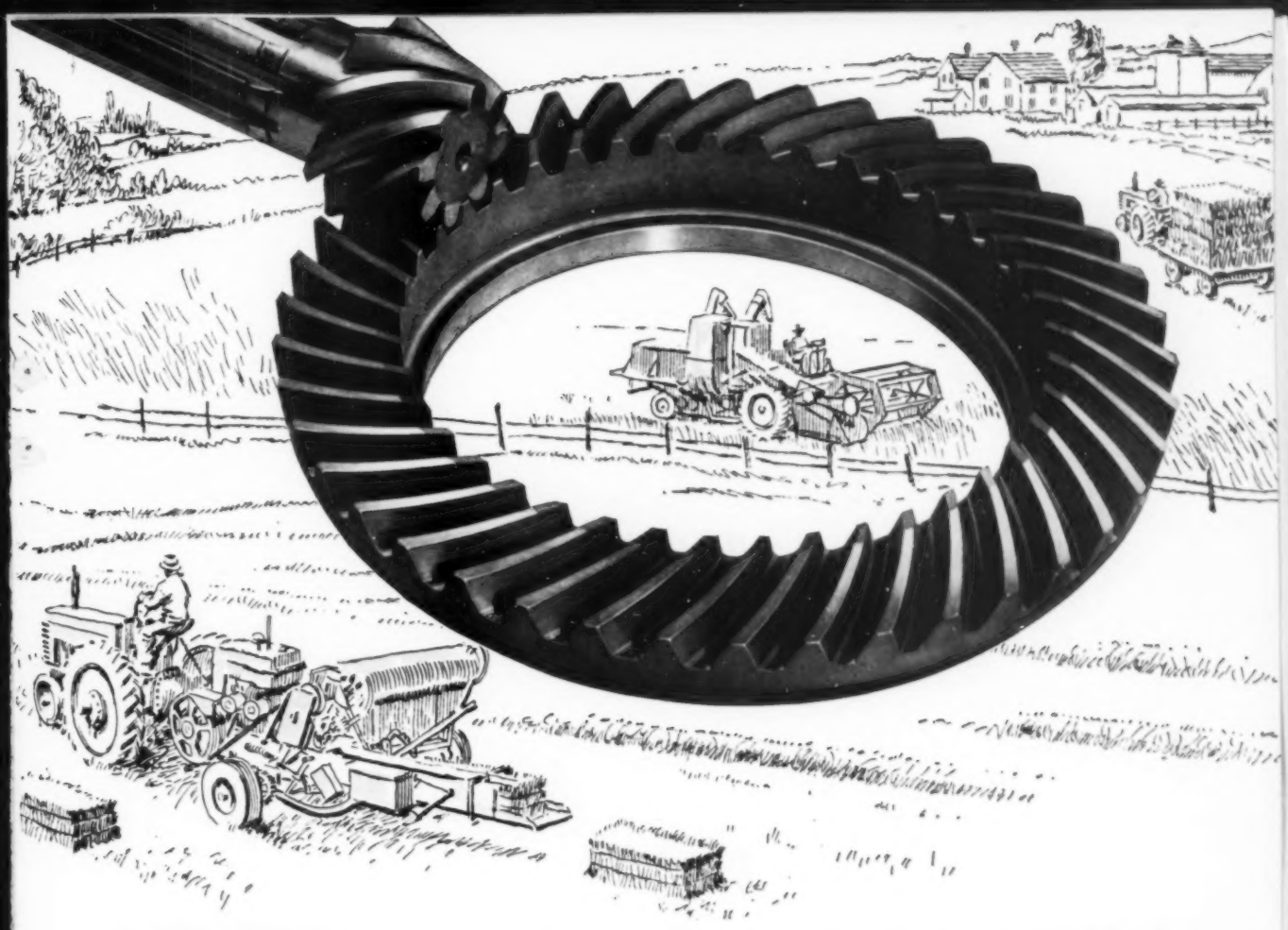

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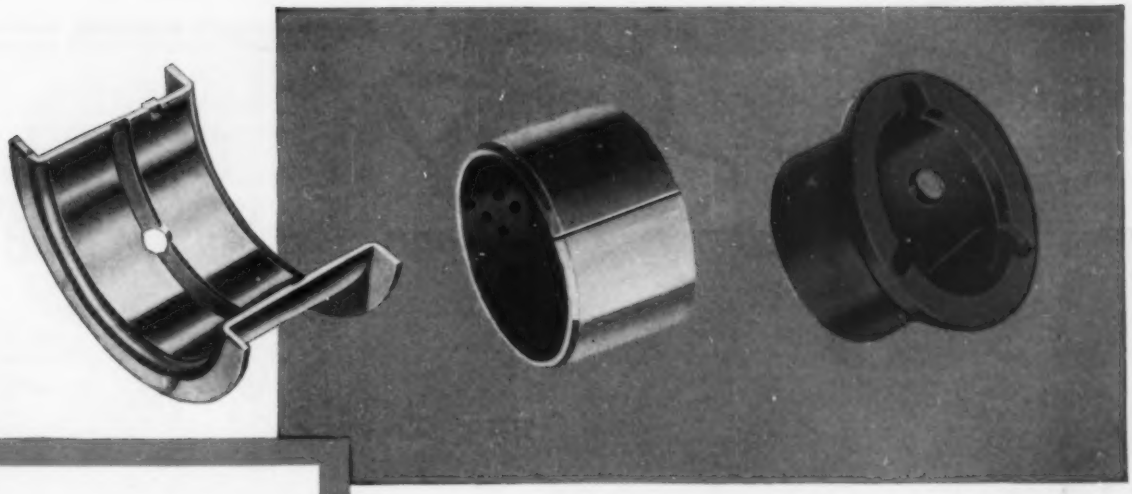

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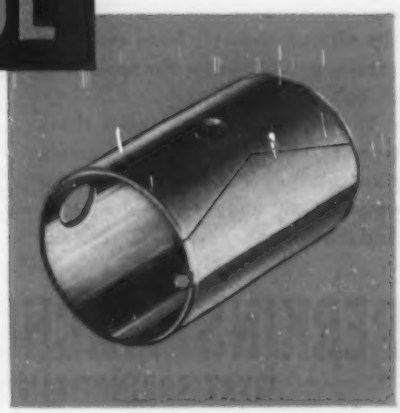

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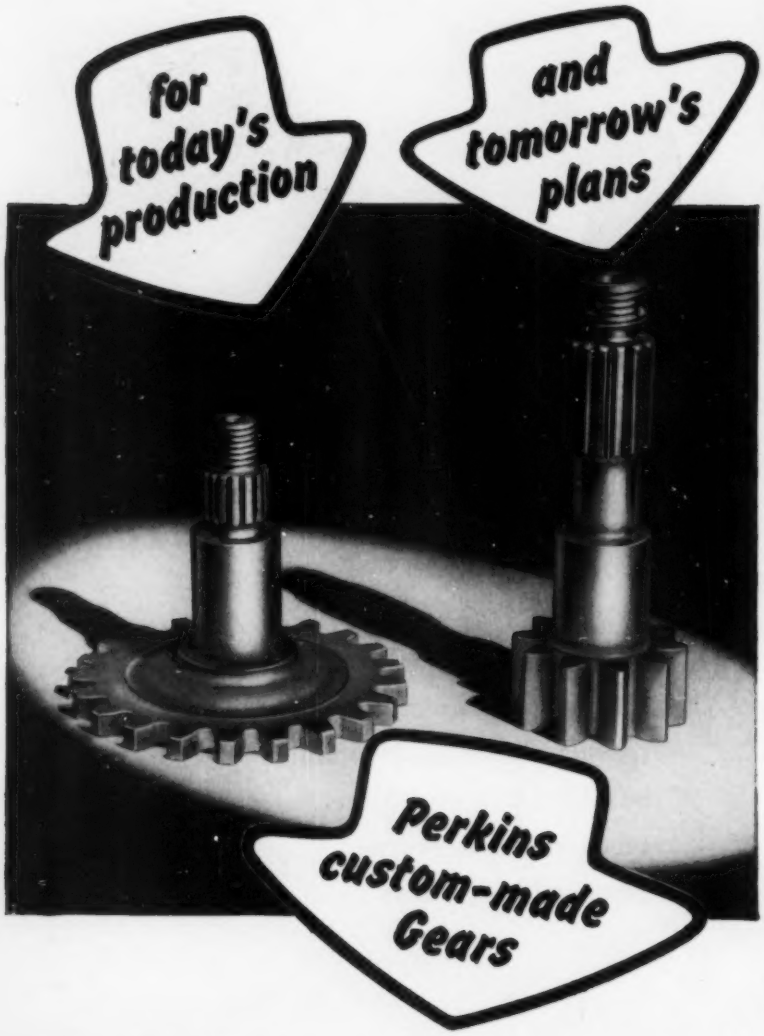

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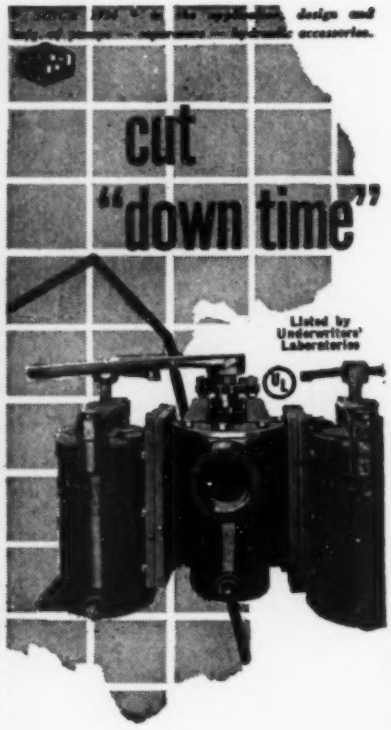

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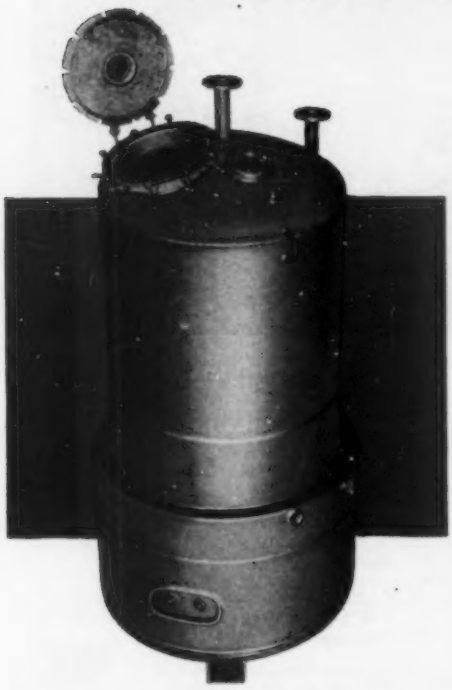
WHEN THE FIRST SELF-PLAYING PIANO WAS INVENTED...



Vacuum cooking kettle of stainless steel.

Koven

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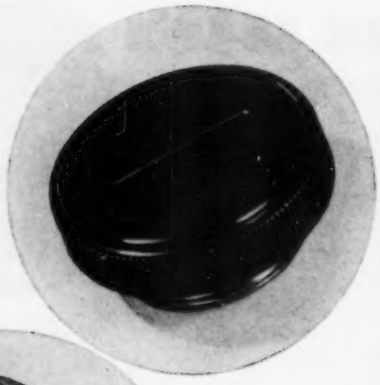
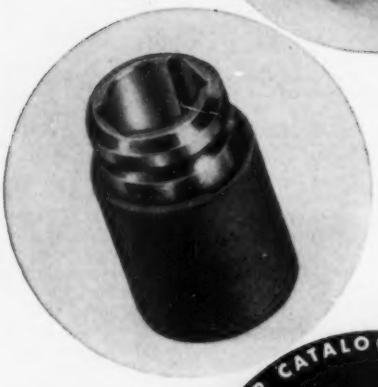
Back in the days when the family first sat back and enjoyed automatic piano music, manufacturers were enjoying speeded-up production with equipment parts made by KOVEN to their exact needs. Now as then, KOVEN's newest techniques harmonize with the most modern facilities—to produce parts usually more efficiently and economically than can be made in your own plant. Tailored to precise requirements, KOVEN Individualized Equipment Parts are used by leading manufacturers throughout the country. Call or write for a consultation — no obligation.

KOVEN FOR INDIVIDUALIZED EQUIPMENT SINCE 1881

Electric Motor





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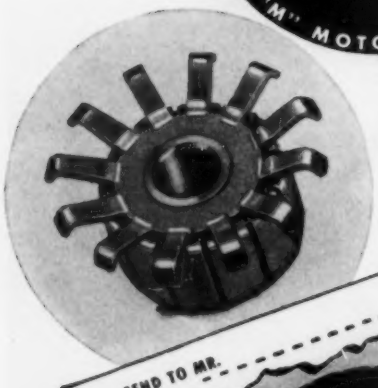

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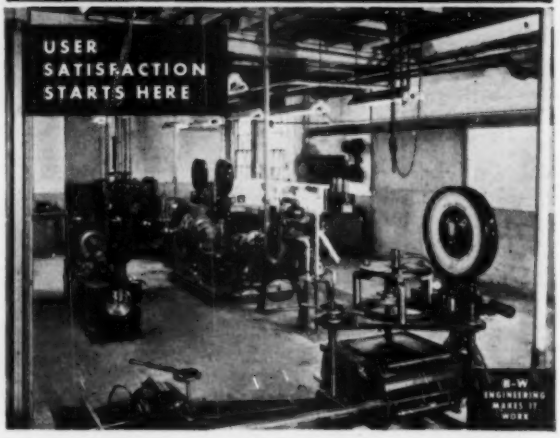
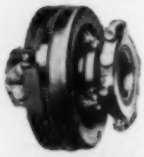


Every type and size ROCKFORD CLUTCH must pass torque, strength, pressure, spin, heat, balance, wear, deflection, friction, run-out, flatness and endurance tests before being put into production. These torture tests are made on specially designed, accurate, clutch-checking machines. Let our engineers give your products the benefit of ROCKFORD test-proved CLUTCH reliability.



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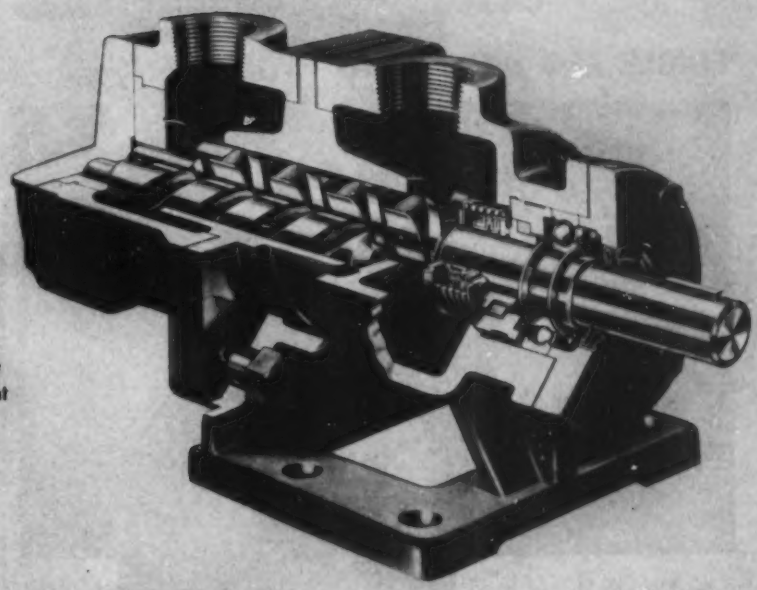
Profit by his sound, versatile experience. He can aid you in selecting the IMO Pump you need . . . give you facts and figures on performance . . . bring valuable judgment to bear on your specific fluid handling application.



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DE LAVAL STEAM TURBINE COMPANY
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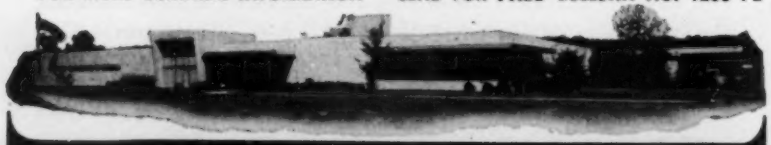

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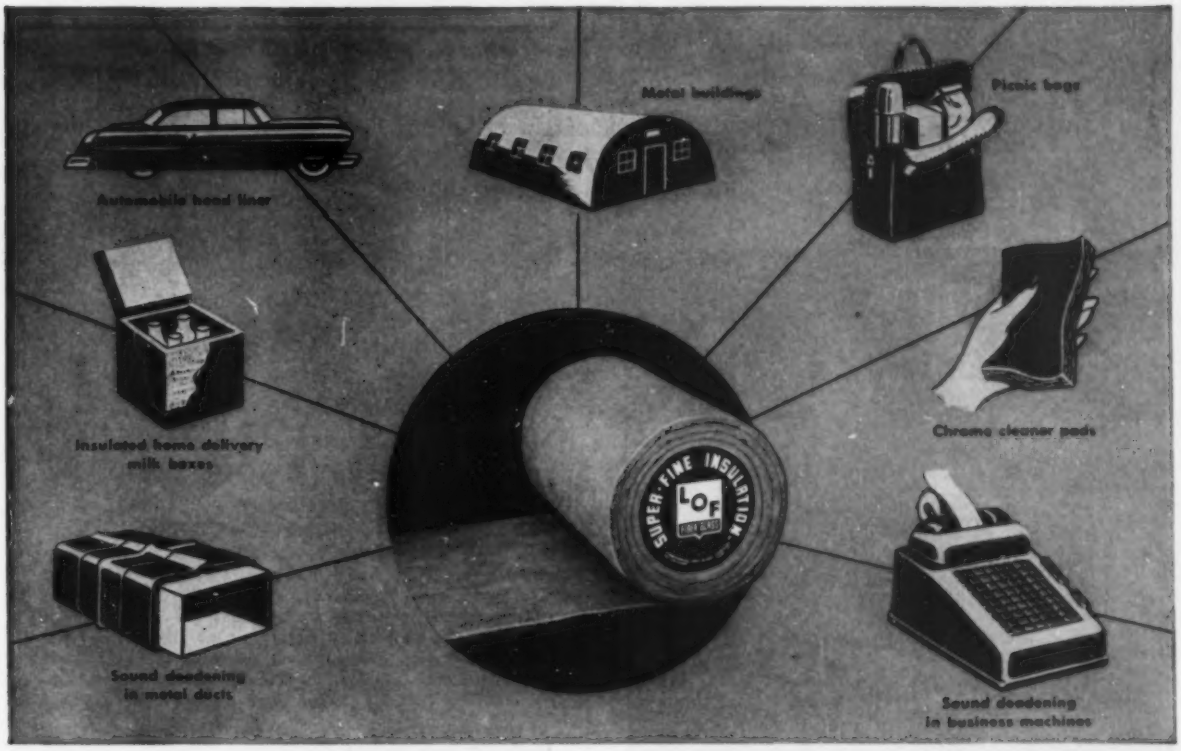

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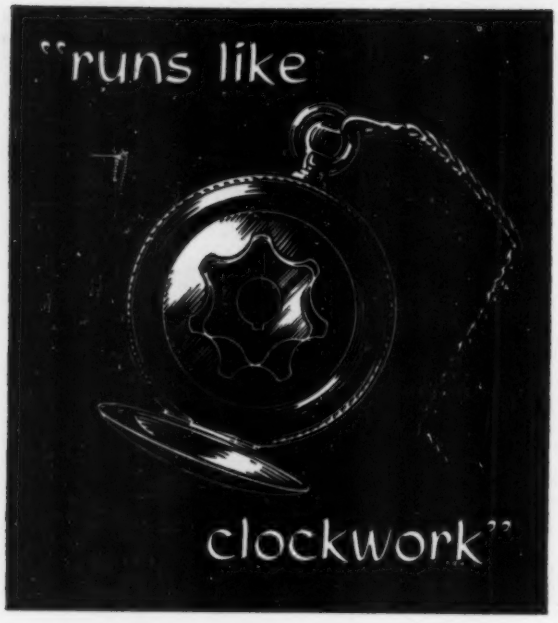

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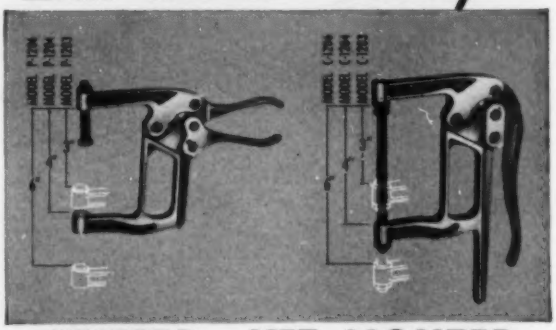

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REQUIRE LESS EFFORT TO CLAMP

Here is another forward step in KNU-Vise clamps for efficient, fast and secure clamping.

These six new clamps made of heat-treated steel forgings are stiffer, yet lighter, and require less hand effort to clamp. At the same time, a greater clamping force is obtained. In addition, the new hand-hold design of the C-Clamp (at right) provides a guard to protect the user's fingers while clamping. A second spindle, instead of the anvil, can be furnished for special applications.

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M3

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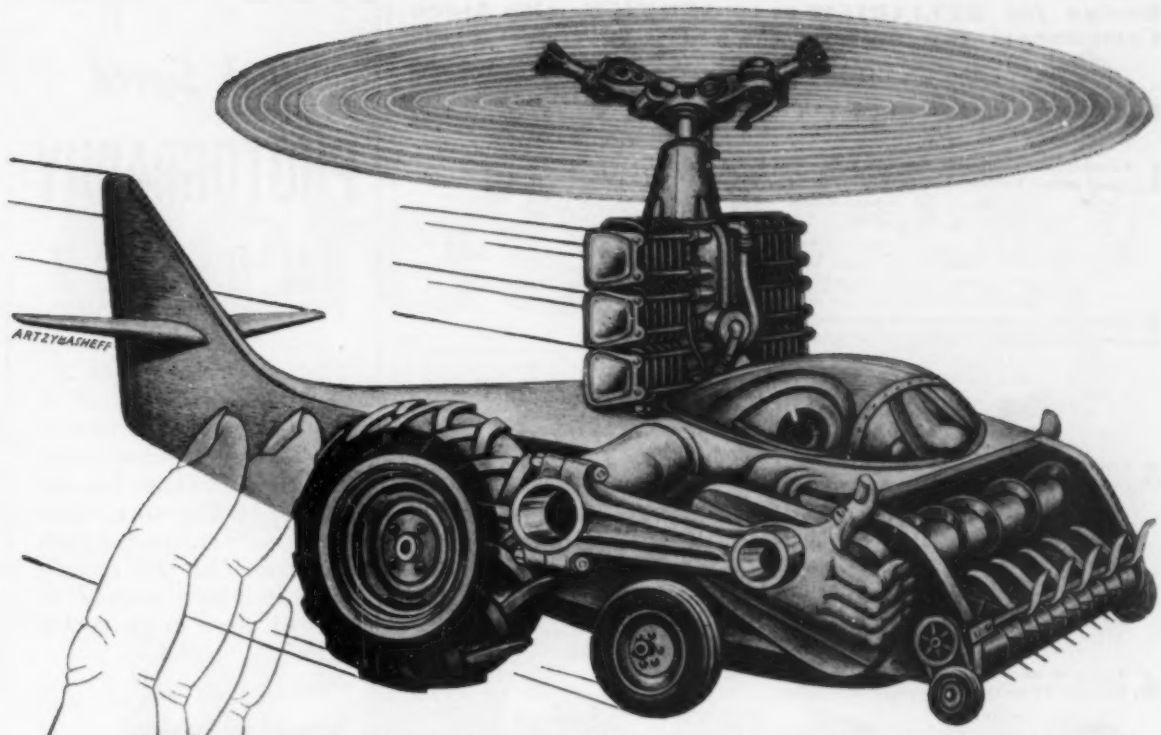

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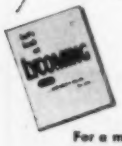

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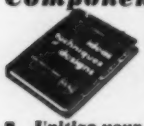
Design for RELIABILITY in SERVICE with Alden Components for PLUG-IN UNIT CONSTRUCTION



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JUMPER STRIP Eliminates wiring for common circuits
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YOUR COMPLETED CIRCUITS FOR PLUG-IN PACKAGE OR CHASSIS

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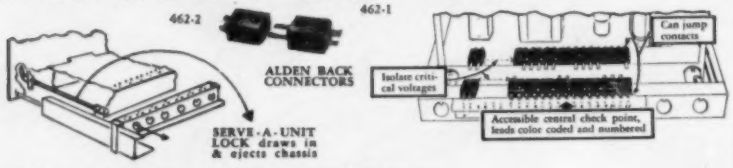
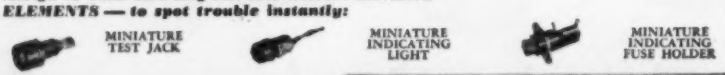
3. *Use ALDEN BACK CONNECTORS and SERVE-A-UNIT LOCK for 100% circuit accessibility and 30-second chassis removal.*



4. *Assign to each unit tiny tell-tale ALDEN SENSING ELEMENTS — to spot trouble instantly:*



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ALDEN PRODUCTS CO.

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It's Vacation Time!

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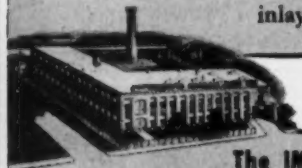
We're taking ours, and closing our plant from June 26th to July 13th. With two weeks of sunshine and rest behind us, we'll be back with renewed effort to continue bringing you a complete line of the finest precious metal inlays and overlays in composite metals.



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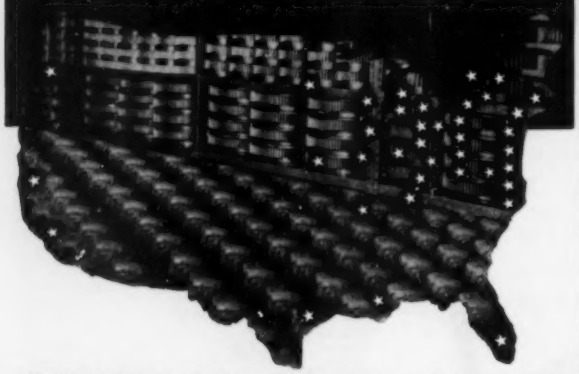

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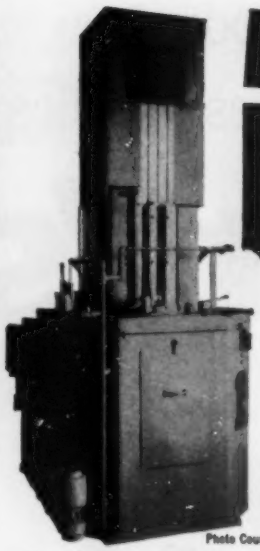

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RUTHMAN GUSHER
COOLANT PUMP

This Acme Model U-31 Broaching Machine is equipped with a Ruthman Pump.

Photo Courtesy Acme Broach Corp.

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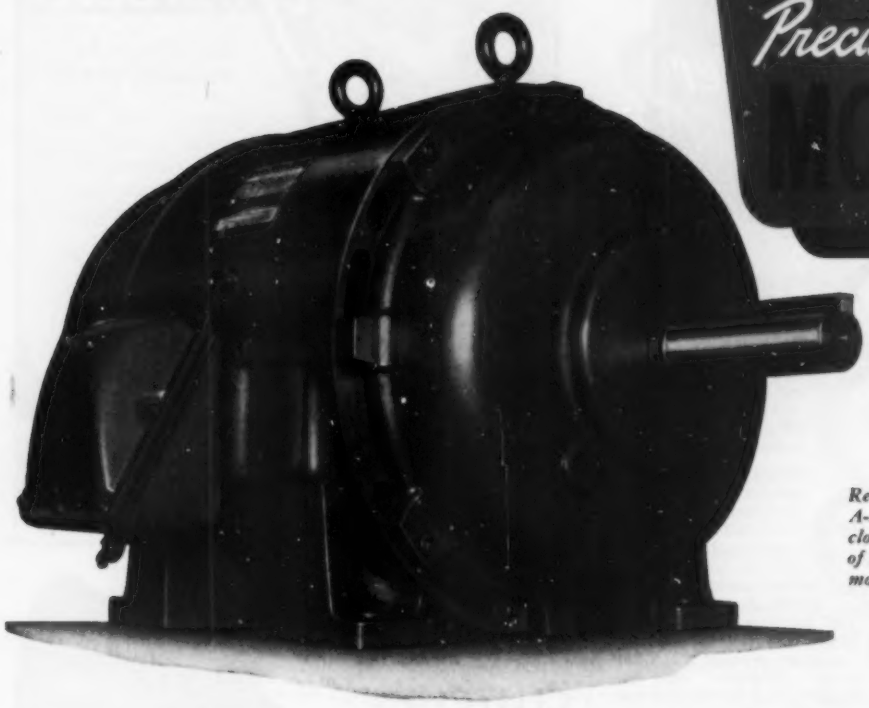

Reliance Totally-enclosed Fan-cooled A-c. Motor. All other standard enclosures available, with wide choice of mechanical designs and special mountings. Ratings from 3/4 to 300 hp.

- ☆ Heavy shafts, bearing to bearing
- ☆ Indestructible pressure-cast rotors
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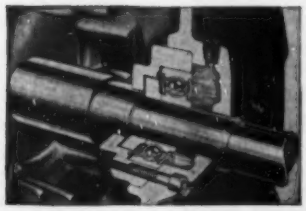

...AND THE BEST PRE-LUBRICATED BEARING DESIGN

The Reliance pre-lubricated bearing provides *four times more operating hours without re-lubrication* than any other bearing used in motors today. And—whatever your lubrication schedule—*you just can't grease'em wrong!* To get the complete "inside story" on motor bearings, write today for Bulletin B-2201. It contains hard facts on the advantages of the Reliance pre-lubricated bearing design, with cutaway view, cross-section diagram, comparison chart, and statements by bearing manufacturers. B-1453

RELIANCE ELECTRIC AND ENGINEERING CO.

1060 Ivanhoe Road, Cleveland 10, Ohio • Sales Representatives in Principal Cities

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Specify **Bendix-Skinner** RIBBON FILTER ELEMENTS . . .

- LOWER ORIGINAL COST
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- NO EXPENSIVE BACK UP SUPPORT REQUIRED
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Our engineering department will be glad to advise on new installations or to furnish replacement units in a variety of sizes. Write us for details.

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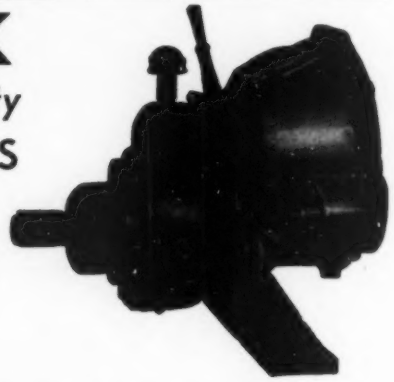
FUNK *Heavy-Duty* CLUTCHES *and* POWER UNIT DRIVES



FUNK Power Take-Offs are available in a wide variety of types to fit most requirements for shaft speed and installation space. Designed to fit any Ford Industrial Engine or standard SAE flywheel housing. *Above* is heavy duty clutch and gear reduction unit. Write for specifications, or for assistance on any special power problem.

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"Ingenious research and the ability to produce . . . which have helped to make the United States the world's greatest nation . . . could not have been realized without the savings of millions of thrifty persons. Savings of individuals financed new inventions, developed others. The Payroll Savings Plan for purchasing Savings Bonds regularly provides an easier way for American workers to save for future spending or investment, for their own security, and for their nation's security. Our experience at the Maytag Company has shown us that a successful Payroll Savings program can be the foundation and the cornerstone of happy employee relations."

Let's point up Mr. Maytag's concise summary of the Payroll Savings Plan with a few very recent figures:

• at the close of February, 1953, the *cash value* of Series E Bonds held by *individuals* reached a new high: $35.5 billion. This is $1 billion more than the value of the Bonds held on May 1, 1951, when E Bonds began to mature.

• to this encouraging reservoir of future purchasing power, 8,000,000 Payroll Savers are adding $160,000,000 per month by their consistent investment in U.S. Savings Bonds.

• unit sales of E Bonds in 1952 reached the highest level of the past six years—more than 77 million individual pieces. Of the 77 million units, 67 million were in the $25 and $50 denominations—the bonds bought chiefly by Payroll Savers.

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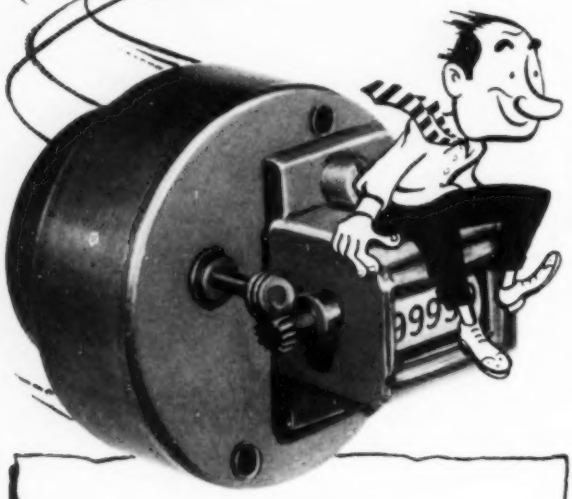
We're making time in COUNTING time



BRISTOL STEPS AHEAD WITH NEW ELAPSED TIME INDICATORS

Two new Bristol Running Time Indicator models are now ready for industrial or laboratory applications. ET-1A counts to 99,999 hours, by hours. ET-1B counts to 9,999.9 by tenths of hours.

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COMPACTNESS — The "Circle B" Motor is compact — fits into a 2" circle, and is only 1 7/64" deep.

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BRISTOL MOTOR DIVISION

VOCALINE COMPANY OF AMERICA, INC.

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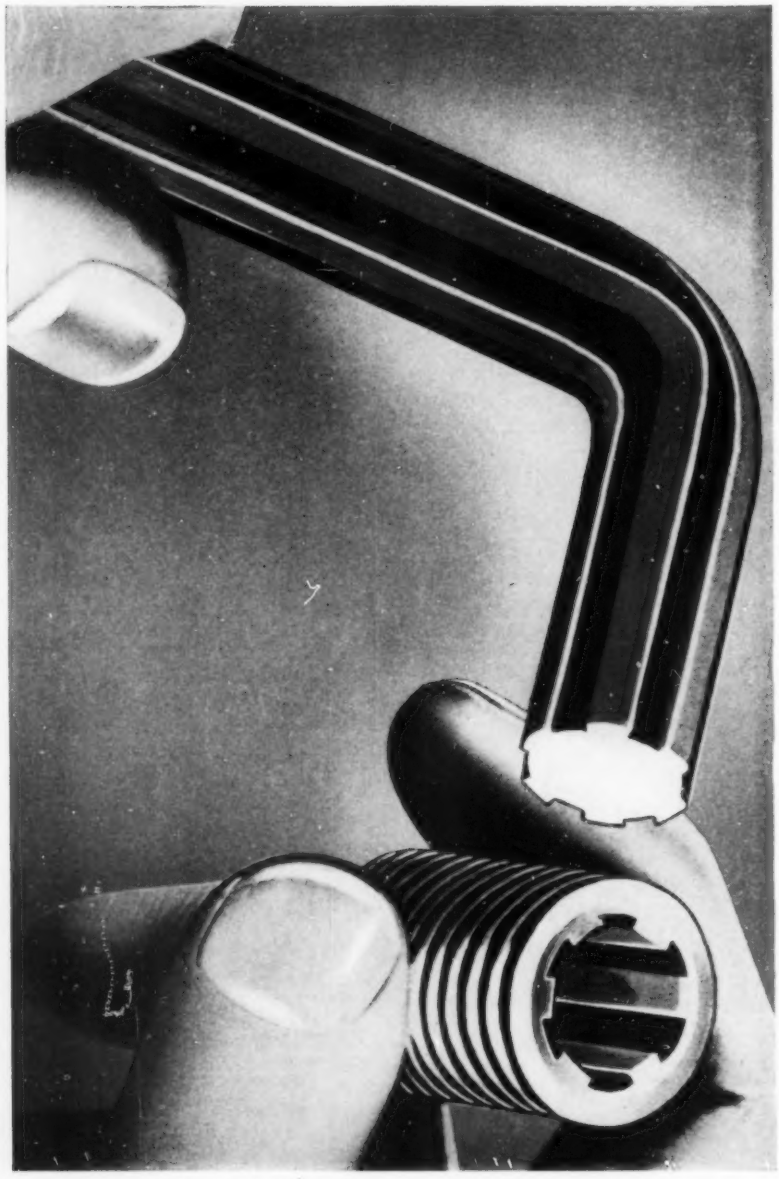
give far greater *HOLDING* POWER



The splining principle is recognized by design engineers as the most effective means of transmitting rotary power. That's why it's used in propeller hubs, drive shafts and automobile axles. In Bristol's Multiple-Spline Socket Set Screws, this design results in strength and holding power unequalled by any other screw.

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A.3.6

BRISTOL'S SOCKET SCREWS

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The Electric Products Co. Deep Well Pump Motors at Big Creek Pumping Station, Mobile, Ala.

NEGLIGIBLE MAINTENANCE under HEAVY THRUST LOAD at HIGH SPEED

The Electric Products Co., Cleveland, Ohio, is one more manufacturer who has found SKF Spherical Roller Thrust Bearings the solution to the problem of anti-friction support of heavy thrust loads at high speeds, and perfect lubrication.

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with SKF SPHERICAL ROLLER THRUST BEARINGS

Here are the reasons why more and more equipment designers are specifying the SKF Spherical Roller Thrust Bearing:

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SKF Bearings are serving virtually all industry. SKF's unmatched Field and Home Office engineering service helps product engineers *put the right bearing in the right place.*

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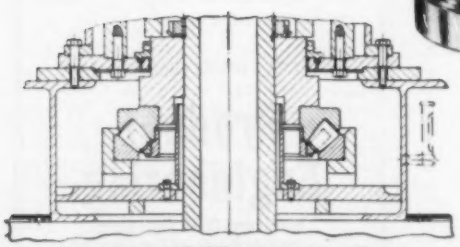

Cross-Section of SKF Spherical Roller Thrust Bearing as designed into the Electric Products Co.'s vertical motors at Big Creek

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Pneumatic Riveters

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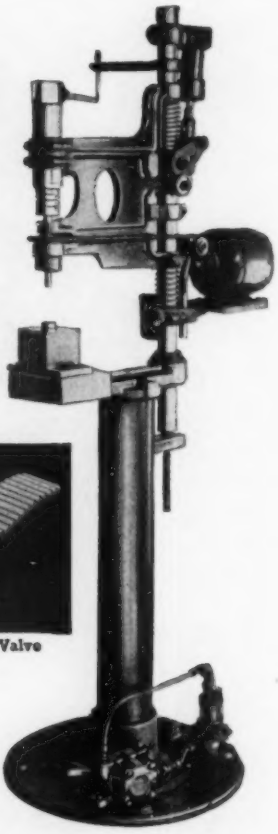
A touch of the foot pedal on the NOPAK model R Foot Valve . . . which is coupled to a special timing valve . . . initiates an automatic riveting sequence on this and other models of the Airflex Riveter made by the Lemert Engineering Co., Plymouth, Ind. Operator fatigue is minimized and production is increased by this successful application and precision control of air power.



NOPAK 3- and 4-Way Foot Operating Valves are used in many ways on many different types of equipment for the precision control of air power applied to various machine movements. Ask your NOPAK representative to show you other examples in the NOPAK Application Manual.

NOPAK Model "R" Foot Valve

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Facts about *HELI-COIL* inserts you should know

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*Heli-Coil** screw thread inserts are precision formed coils of stainless steel or phosphor bronze wire. Wound into tapped holes, they form permanent, non-corrosive, strip-proof threads of astonishing strength. Available for National Coarse, National Fine and Unified threads, pipe threads and spark plug threads. They are made in all standard sizes and lengths for assemblies requiring Class 3, 3B, 2 or 2B fits.

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FOR PRODUCTION SALVAGE: When conventional tapped holes are damaged in production, restore them on the line with *Heli-Coil* inserts. Get better-than-original strength with no increase in screw size and no tell-tale signs of rework.

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Holes are drilled and tapped as you do for ordinary threads—then *Heli-Coil* inserts are wound into tapped holes by hand or power tools. Install in a few seconds, assure thread protection forever. Can be used in any metal wood or plastic.

No other method is so simple, effective and practical.

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Heli-Coil inserts *save money* because they strengthen threads and make *fewer* smaller fastenings do the same holding job. They make *lighter* bosses and flanges practical and they *save weight* in two ways: (1) by permitting use of cap screws, instead of bolts and nuts; (2) by allowing use of smaller, shorter, fewer cap screws. *Heli-Coil* inserts *protect* your product from thread wear, galling and stripping for life in every kind of metal, in plastics or wood. They preserve customer good-will by preventing product failure, due to thread fault. *Heli-Coil* inserts improve the end product, cut rejects, salvage threading errors.

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3. *Save* weight and reduce bulk in assemblies.
4. *Save* assembly time by using cap screws instead of nut-and-bolt assemblies.
5. *Save* rejections in production. Threads damaged on the line are quickly repaired. You save time. Reduce scrap.
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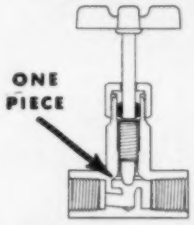

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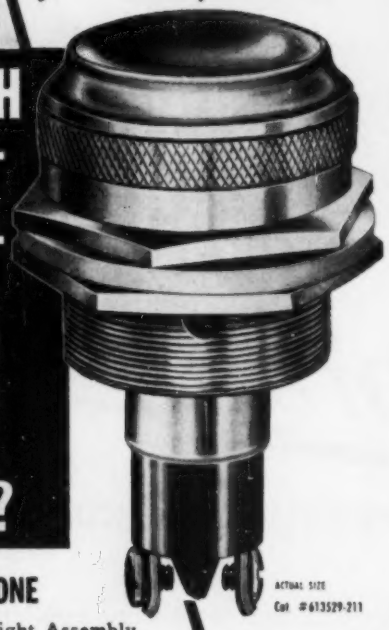

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This Pilot Light Assembly was first made to accommodate the *S-11 lamp* and was intended for use in the cabs of great diesel locomotives.

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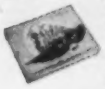

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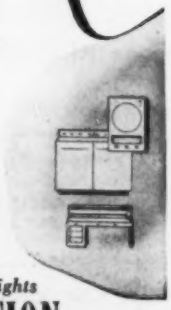

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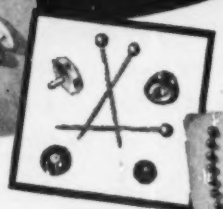
TINY **INJECTION MOLDED PRECISION PLASTIC PARTS**

Completely automatic . . . parts delivered trimmed, ready for use, in one operation, with Gries' speedy, specialized production facilities. NYLON A SPECIALTY.



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Automatic insert feed permits wide variety of product possibilities.

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CONTINUOUS INSERTS
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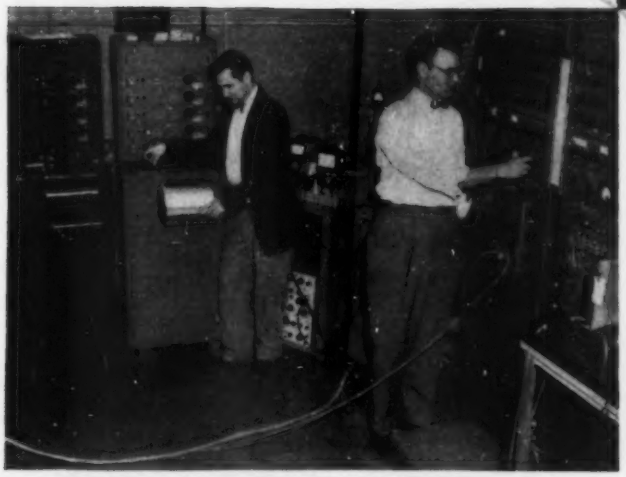
SANBORN OSCILLOGRAPH RECORDING SYSTEMS HAVE MANY APPLICATIONS

Sanborn Recorders Help Speed Flight Design

SPERRY GYROSCOPE COMPANY uses a two-channel Sanborn Recording System for basic research on their Zero Reader* Flight Director, a device which simplifies the manual control of aircraft. The Sanborn System shown above is recording the output of a flight simulator that solves Zero Reader equations.

*T. M. REG. U. S. PAT. OFF.



At McDONNELL AIRCRAFT CORPORATION the movements of a guided missile are simulated by high-precision analog computers which in turn send *eight* different resultant electric signals into two Sanborn four-channel Recording Systems (left) for the graphic recording of the hypothetical results of the guided missile problem.

FOUR CHANNEL

TWO CHANNEL

ONE CHANNEL

At DOUGLAS AIRCRAFT COMPANY'S Flight Test Section, a Sanborn two-channel Recording System (shown removed from case for field operation) is used in conjunction with a telemeter radio link to record surface motion vibration on a flying aircraft while it is performing tests requiring continual monitoring. Recorded tracings provide the necessary permanent visual time history for comparison of the two events recorded and a study of their individual characteristics.

How can Sanborn help you?

Sanborn one-, two-, and four-channel Recording Systems can provide an accurate and permanent graphic registration of almost any electrical phenomena whose frequency spectrum falls within the range of zero to 100 cycles per second. The availability and ready *interchangeability* of amplifiers and preamplifiers offer a wide range of use.

Records are traced by heated stylus on plastic coated strip-chart paper, and are in true rectangular coordinates. Other Sanborn advantages include: a high torque movement (200,000 dyne cms per cm deflection); built-in code and time markers; and a wide choice of paper speeds and channels.

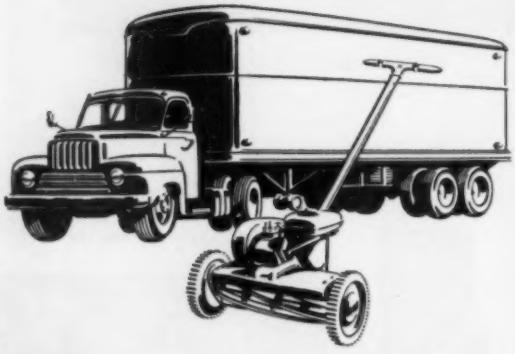
Sanborn engineers will be pleased to make recommendations as to what type of equipment will best solve your recording problem. When writing, include the lower and upper limits and the frequency range of the phenomena to be recorded, and the type of transducer.

Ask for a copy of our "Applicability Folder" which presents a table of uses, complete performance data and specifications, brief descriptions of Sanborn Recording Systems and explanations of how their amplifiers may be readily interchanged.

SANBORN CO. INDUSTRIAL DIVISION
CAMBRIDGE 39, MASSACHUSETTS

Zenith

HAS A WIDE RANGE OF CARBURETOR TYPES



TO FIT A WIDE RANGE OF APPLICATIONS!

Are you looking for an unusual size or type of carburetor? Perhaps Zenith* has the answer to your problem. For more than 35 years Zenith has been designing and building carburetors for every type of engine—ranging from single cylinder lightweights to the most rugged and powerful of gasoline engines. The chances are you can use a unit Zenith is now making and avoid the cost of a specially designed carburetor.

On the other hand, if your carburetor requirements are highly specialized, Zenith's engineering experience will prove invaluable in solving questions of placement, efficiency and economy of operation. Just remember, whatever your carburetor problem, it will pay you to look to Zenith for the answer.

*REG. U. S. PAT. OFF.

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DIVISION OF Bendix AVIATION CORPORATION

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Porcelain Enamel is glass-hard and steel-strong, consequently products finished with this material render exceptional service in applications requiring resistance to scratching or abrasion. Typical products in which this property is especially valuable are: chutes, conveyor buckets, wearing plates, shaft bearings.

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Emissivity—the heat emitting value—of Porcelain Enamel is higher than that of almost any other material. This can be an important advantage for many products.

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Porcelain Enamel gains its strength and rigidity from the steel base. Because of this, Porcelain Enamel is ideal where a strong, lightweight, durable material is required.

Extra CLEANLINESS

For products used where strict sanitary conditions must be maintained, or where ease of cleaning is important, Porcelain Enamel is unsurpassed. Its hard, smooth non-porous surface does not harbor dirt, germs, or foreign matter and surface soil is readily removed.

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Lifetime PORCELAIN ENAMEL — PORCELAIN ENAMEL INSTITUTE

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STOW flexible shafting!

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◀ ***Write today*** for your free copy of Bulletin 525 containing complete engineering data on STOW flexible shafting.

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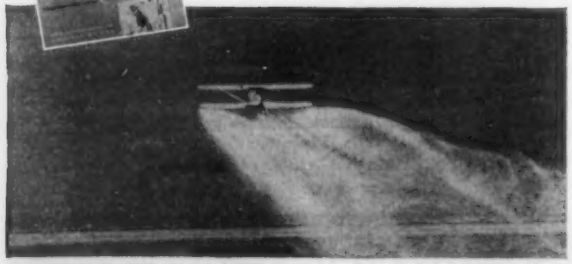

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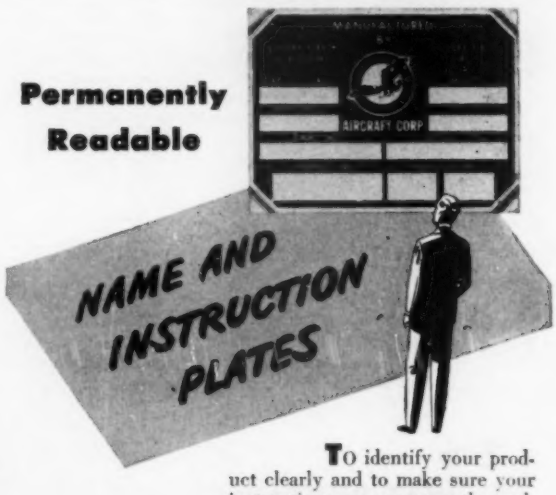

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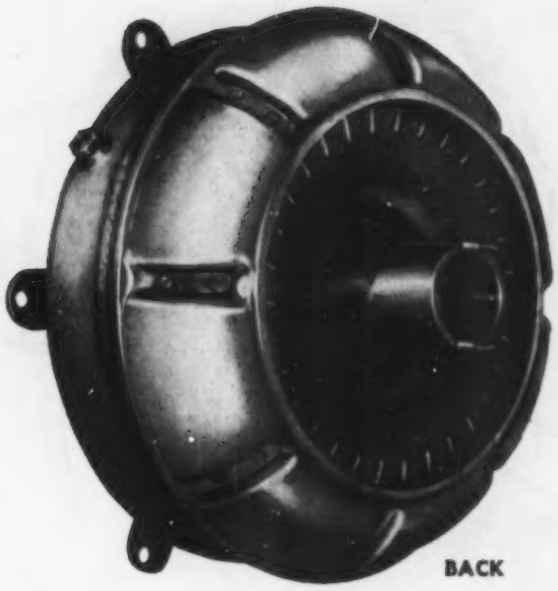

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Welded for strength, with leak-proof construction. Designed for direct air-cooling, but oil cooler may be added.

You Equip WELL...at LOW Cost with LONG TORQUE CONVERTERS!

Designed and built to hold *your* costs down in most applications. Long Torque Converters are now in high-volume production for passenger car use. Easily modified for many industrial uses. We are glad to provide engineering cooperation, through to a satisfactory installation, to manufacturers of original equipment. For complete information manufacturers in volume production should address:

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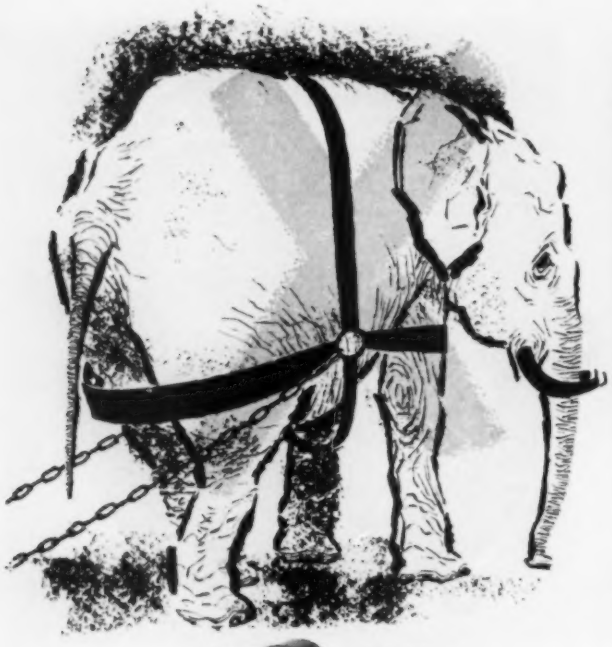

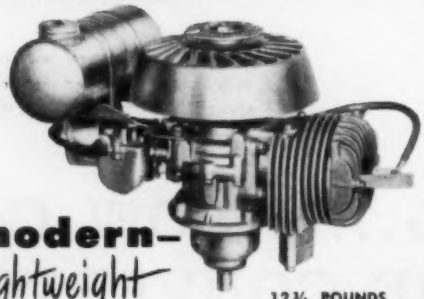

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ALLEN MFG. CO. ALLMETAL CABLE CLIPS

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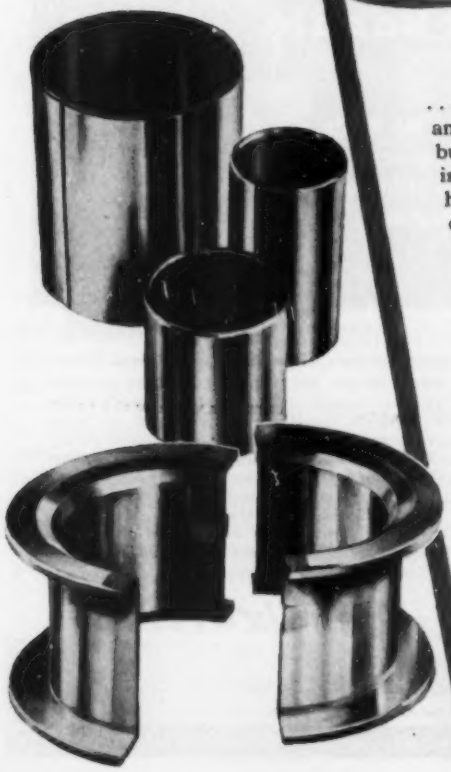
SOLVE MANY SPECIFIC PROBLEMS



The sleeve bearing is basic in principle . . . for most applications man's genius has never invented any device to replace it. For instance, every internal combustion engine is dependent on it, and the majority of industrial equipment is, too. But modern requirements, high speeds, higher loads, and changing designs have called for new sleeve bearings. Johnson Bronze, alert to the demands of new engineering trends, is producing Johnson Modernized Sleeve Bearings, capable of giving the utmost service under these modern conditions. Aluminum bonded to steel is one of them. Copper-lead bronze-on-steel is another. New materials, new combinations of materials and new designs are meeting many new requirements. If you have a specific sleeve bearing problem, perhaps a Johnson engineer can help you. Write for an appointment.

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JOHNSON BRONZE PRODUCES ALL TYPES OF SLEEVE BEARINGS: ALUMINUM-ON-STEEL • CAST ALUMINUM ALLOY • BRONZE-ON-STEEL, copper lead • STEEL BACK, babbitt lined • BRONZE BACK, babbitt lined • CAST BRONZE, plain or graphited • SHEET BRONZE, plain or graphited • LEDALOYL powder metallurgy

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ARE DOUBLE LUBRICATED GIVE DOUBLE PROTECTION

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Precision made to close tolerances these rugged, self-aligning bearings are available for light, normal and heavy duty on shafts from ½" to 3 15/16" inclusive.

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manufacturers of components for servomechanisms and computers, has recently established a subsidiary with headquarters in Milano, Italy, where the following activities will be performed:

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Best handle . . . by far!

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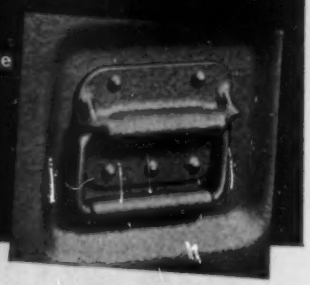

Attention manufacturers of portable equipment, carrying cases, parts boxes, etc.! If your product requires side-carry handles, install the best—the Bendix-Friez handle. This superior handle was developed to meet strict military requirements for many specialized equipment uses. Ruggedly built of aluminum and stainless steel in a sturdy design, it knows no equal for long, faithful service. Can be riveted or welded to any kind of container . . . or depressed in the surface, if desired. Unique "snap-back" feature stops rattle from shock and vibration. Prompt attention to both large and small lot orders. Try us today.

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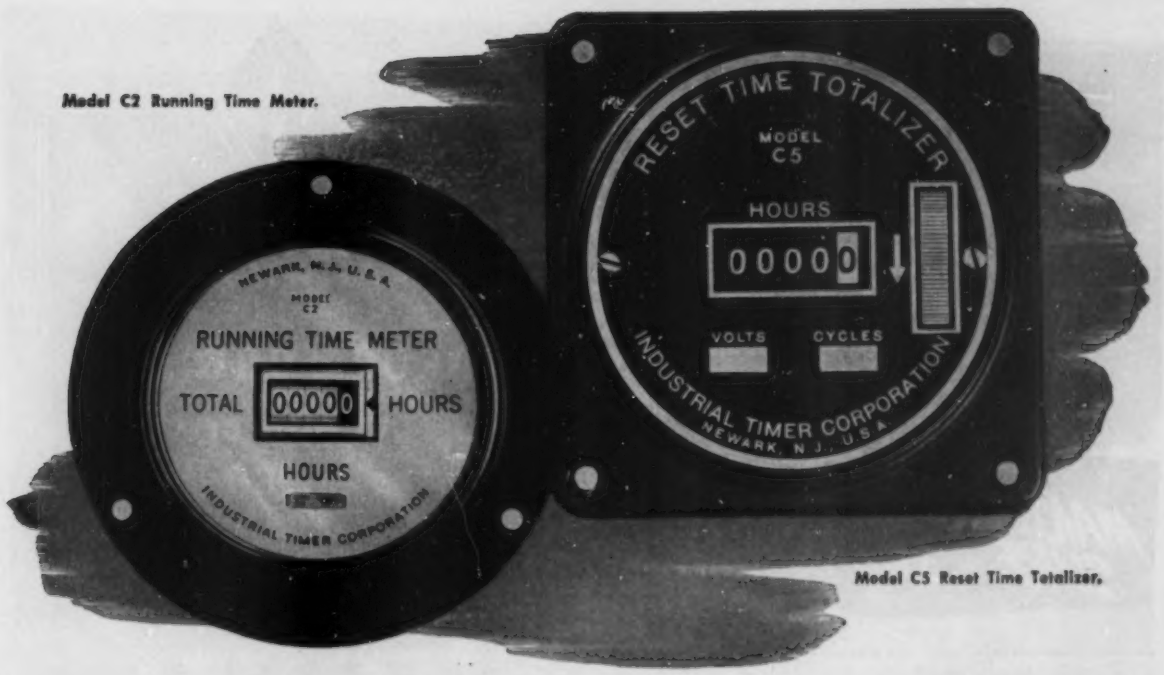

Model C2 Running Time Meter.

Model C5 Reset Time Totalizer.

NOW BOTH! Reset and Non-Reset Elapsed Time Meters

For applications where it may be desirable to reset to zero at any time, Industrial Timer now offers Reset Time Totalizers, in addition to its Running Time Meters.

SYNCHRONOUS MOTOR DRIVEN. Both types of elapsed time meters provide you with an exact record of machine hours on A.C. operated machines... up to 100,000 hours with "electric clock" running accuracy. Both utilize heavy duty synchronous motors that are self lubricating for long life. And both are available in enclosed and open type models. Running Time Meters are enclosed in black bakelite cases. Reset Time Totalizers in steel housings with baked black finish.

WIDE VARIETY OF APPLICATIONS. These Industrial Elapsed Time Meters permit you to compute readily production costs on A.C. operated machines — predict replacements for equipment of predetermined life expectancy. They can be used in a wide variety of applications such as: radio transmitters, vacuum tube devices, refrigerators, oil burners, molding machines, life test equipment, diesel generators, conveyors and many other types of machinery and equipment. For technical data, request Bulletin 88-53.

Reset Time Totalizer — Model Designations

CASED	OPEN	COUNT	RANGE	VOLTAGES	CYCLES
C 5		1/10 hr.	10,000 hrs.	115,220	60,50,25
	C 7	1/10 hr.	10,000 hrs.	115	60,50,25
C 5A		1 hr.	100,000 hrs.	115,220	60,50,25
	C 7A	1 hr.	100,000 hrs.	115	60,50,25

Running Time Meters — Model Designations

CASED	OPEN	COUNT	RANGE	VOLTAGES	CYCLES
C 2		1/10 hr.	10,000 hrs.	115,220,440	60,50,25
	C 4	1/10 hr.	10,000 hrs.	115	60,50,25
C 2A		1 hr.	100,000 hrs.	115,220,440	60,50,25
	C 4A	1 hr.	100,000 hrs.	115	60,50,25
C 2D		1/10 min.	10,000 min.	115,220,440	60,50,25
	C 4D	1/10 min.	10,000 min.	115	60,50,25
C 2F		1 min.	100,000 min.	115,220,440	60,50,25
	C 4F	1 min.	100,000 min.	115	60,50,25

MANUFACTURERS OF THESE AND OTHER TIMERS AND CONTROLS FOR INDUSTRY — CAM TIMERS • TIME DELAY TIMERS • AUTOMATIC RECYCLING TIMERS MANUAL SET TIMERS • INSTANTANEOUS RESET TIMERS.

Timers that Control the Pulse Beat of Industry

INDUSTRIAL TIMER CORPORATION

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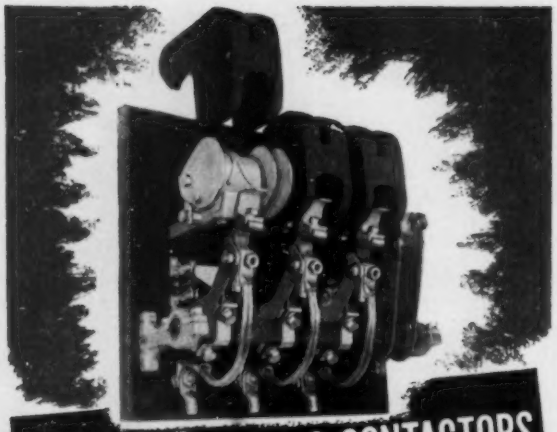

MAKE SURE YOUR A-C CONTACTORS PASS THIS TEST

		E.E. Contactors	Other Contactors
1	Stamped-steel, welded construction assures extra strength.	✔	
2	Light-weight, fast-moving parts provide quick operation. No die-cast parts	✔	
3	Self-lubricating, porous-bronze bearings.	✔	
4	Extra-wide, heavy-duty contacts (¾").	✔	
5	Compact design . . . lessens required mounting space.	✔	
6	Lift-off arc shields for quick contact inspection.	✔	
7	Standard electrical interlock has n.o. and n.c. contacts - electrically separate	✔	
8	Stainless-steel springs on both main and auxiliary contacts.	✔	
9	Arc-centering design . . . assures longer arc-shield life.	✔	
10	Unusually high rupturing capacity. Highly efficient blow-out system.	✔	

Make these ten, top-priority features the guideposts in selecting A-C Contactors. You'll find Euclid Electric Contactors thrive on comparison because *only* Euclid offers all ten. *Plus* sound design, *plus* precision workmanship, *plus* 30 years of experience that make E.E. the leader in motor-control apparatus.

Ask your E.E. Representative for more information, or write:

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DROP FORGINGS . . . any size or shape up to 200 lbs.

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for quick permanent coloring
of stampings, engravings,
symbols and designs

For use on metal, glass, ceramics, plastics

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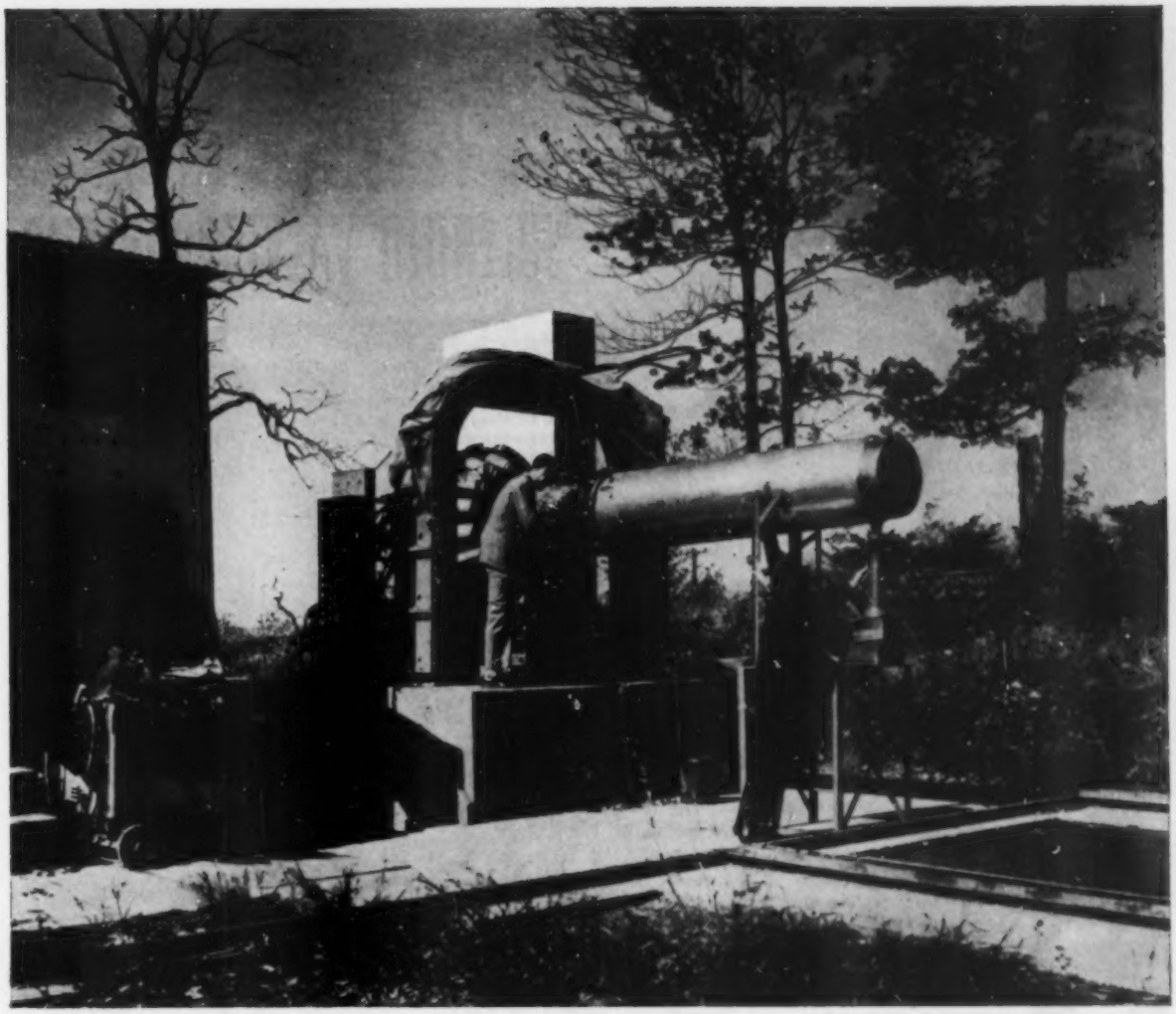

It's the Test by Fire for High Alloy Steel

A jet engine on a test stand represents the kind of metal-killing service that no steel could stand until A-L pioneered in suitable high-temperature alloys. Then, *and only then*, came aircraft superchargers, jet and rocket engines, gas turbines, etc. ● You may have a problem of corrosion or heat resistance—of strength with light weight—or of special electrical requirements. The right special alloy steel can solve it, and we're the people to see. ***Allegheny Ludlum Steel Corporation, Oliver Building, Pittsburgh 22, Pa.***

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Allegheny Ludlum

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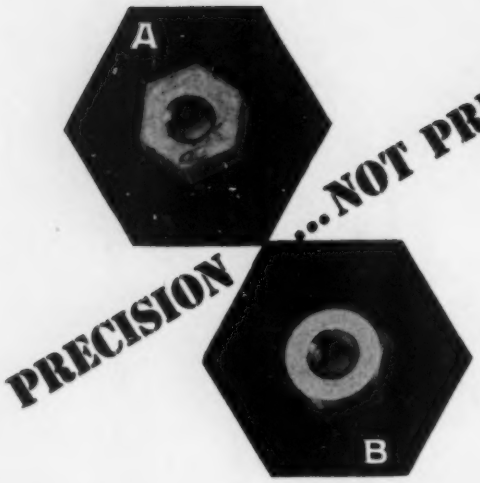
LEADING PRODUCER
HIGH-ALLOY STEELS

W&D 4401-B



PRECISION ...NOT PRICE!

makes the difference

A . . . this is an unretouched photo of a common punch nut. Compare it with the . . .

B . . . unretouched photo of a "Fischer Turned" Brass Nut. See the difference precision manufacturing makes?

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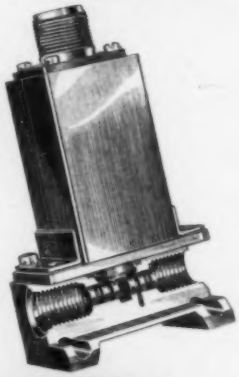

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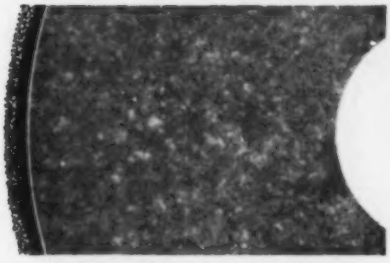
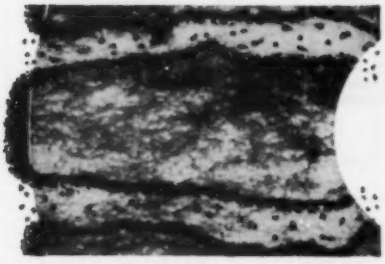
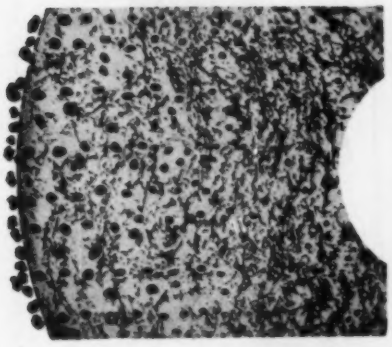


Compare MICRO-KLEAN with FILTERS WITH THE SAME DENSITY THROUGHOUT. The filter media density is the same on the pressure and discharge surfaces of the element; therefore, dirt accumulation is largely on the outside surface, choking the cartridge ("plastering") and reducing the effective filter life.



Compare MICRO-KLEAN with FILTERS WITH HAPHAZARD DISTRIBUTION OF FILTER MEDIA. Uneven haphazard media density permits fluid to find channels through the filter, and pass solids larger than the minimum filter spacing.



Now Look at the advantages offered by MICRO-KLEAN. See how the fibre density increases toward the discharge side of the MICRO-KLEAN filter cartridge? In effect, every Cuno MICRO-KLEAN cartridge is an infinite multiplicity of screens, ranging from relatively coarse on the outside down to 10 microns in the center. Because of MICRO-KLEAN'S graduated density in depth, particles are entrapped within the entire depth of the filter element, giving the cartridge a much longer effective life. Standard cartridge size is 9¾" long by 2¾" O. D., in densities of 10, 25 and 50 microns.

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- longer effective cartridge life

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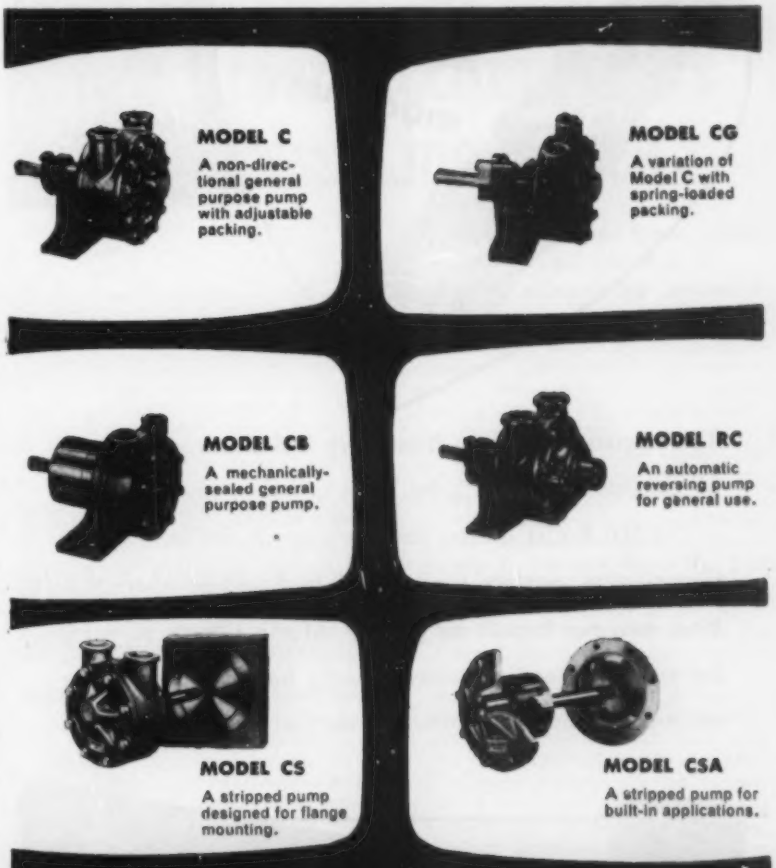

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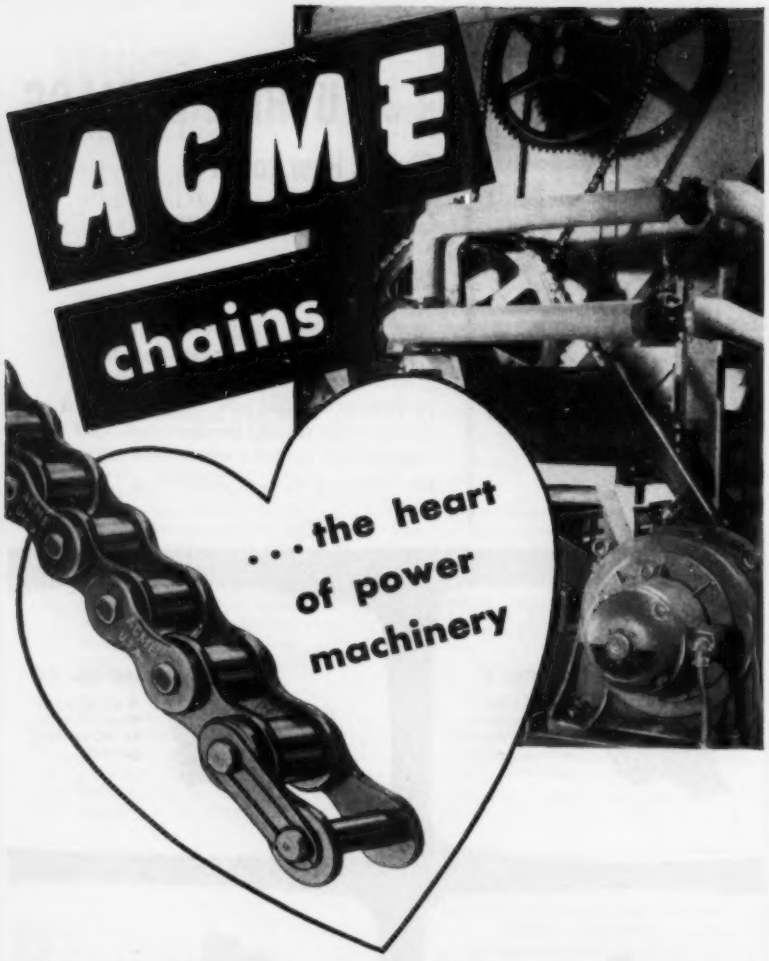

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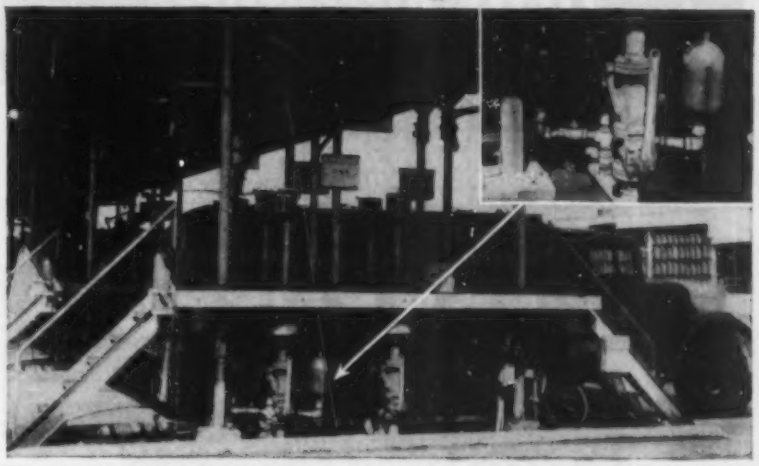
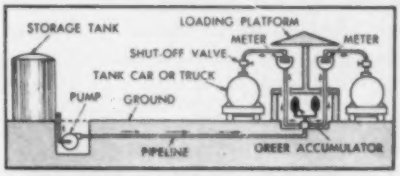
Functions and Applications of the Greer Accumulator

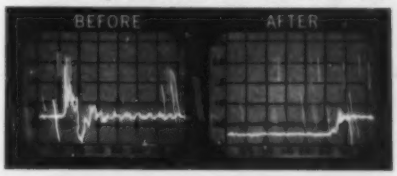


To reduce line shock effectively only two Greer Accumulators were necessary to handle this series of loading racks for petroleum bulk station. Inset: closeup of installation.

How Greer Accumulators Suppress Line Shock



Above: a schematic of bulk station operation. Below: hydrauliscope gives conclusive evidence that line shock was reduced more than 100% when three valves were closed at once. Write for hydraulic line shock Bulletin 600.



Pressure surges from rapid opening and closing of valves effectively reduced

In loading tank cars or trucks from petroleum bulk stations as an example (see schematic diagram on left), the amount of fuel pumped into a tank must be carefully measured by flowmeters.

By just opening and closing the shut-off valve, line shocks develop with great intensity to cause repetitive flowmeter failures that result in erroneous readings. This can be costly to the operator selling this fuel at a given price.

By installing Greer accumulators that function as perfect shock absorbers, these dangerous pressure surges are made harmless (see hydrauliscope test on left). The elimination of costly flowmeter and pipeline maintenance more than paid for the accumulators within a year.

If your problem is hydraulic line shock, a Greer accumulator is the answer. Let our engineers help you. Call or write today. No obligation.

Greer accumulators have many uses as:

(1) Pressure storage chamber for main, auxiliary and emergency power (2) Pressure-volume compensator for leakage and temperature (3) Dispenser of fluids and lubricants (4) Transfer-barrier for fluids and gases (5) Shock absorber for line shock and pump pulsation.

Precision engineered to make any hydraulic system better! Complete data and diagrams in Brochure 301. Write for your free copy.

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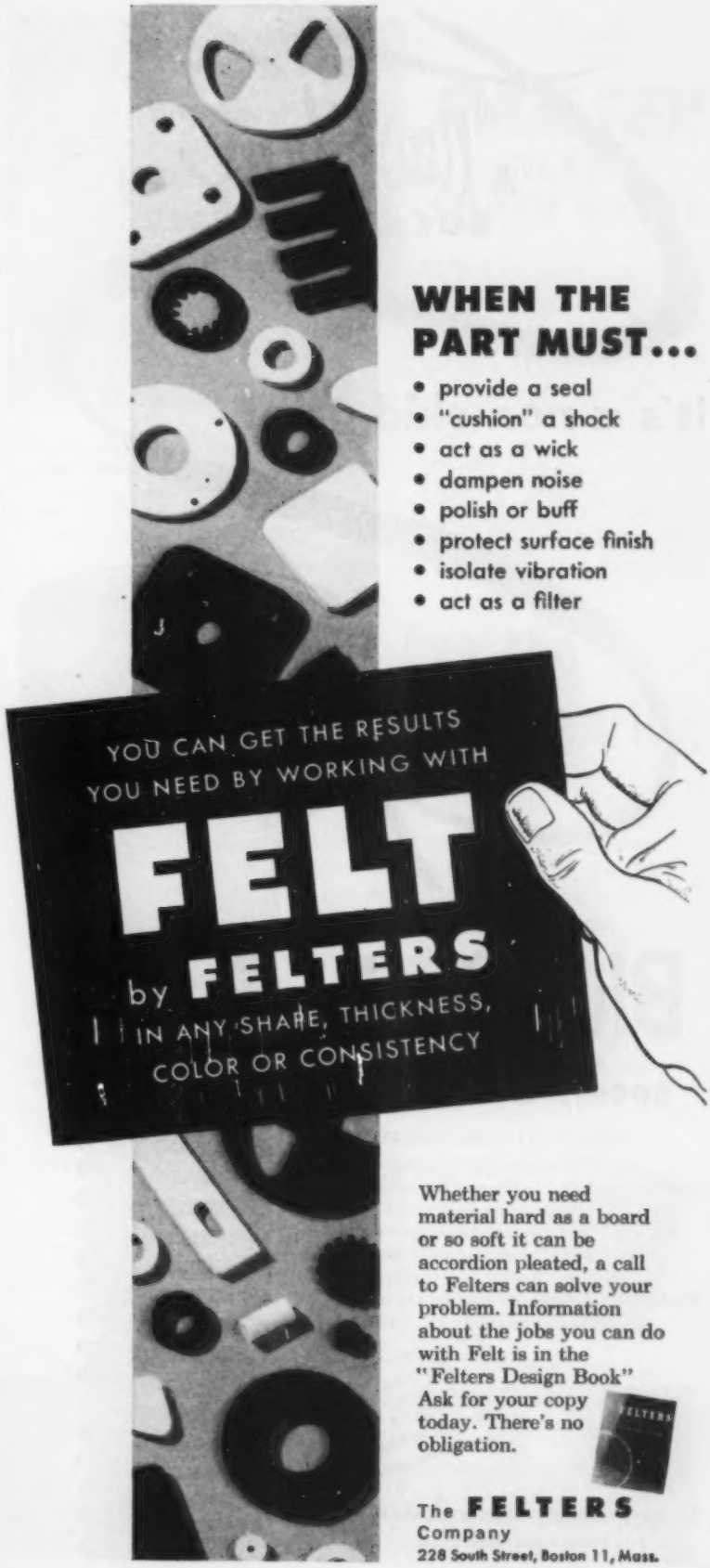

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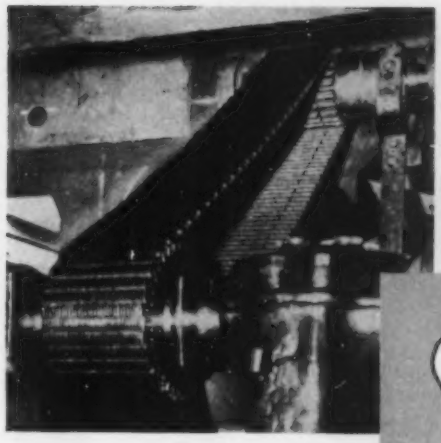

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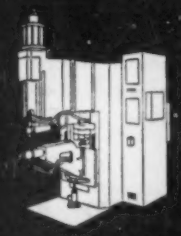

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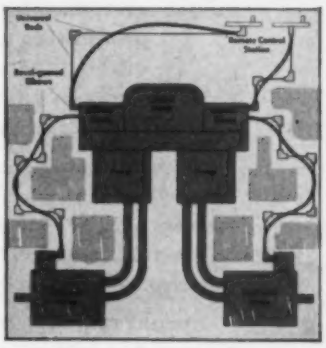

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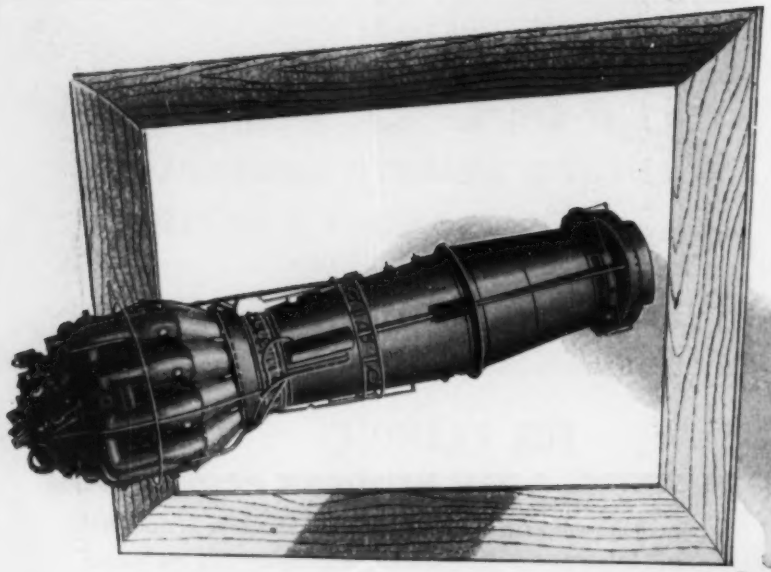

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A-6815

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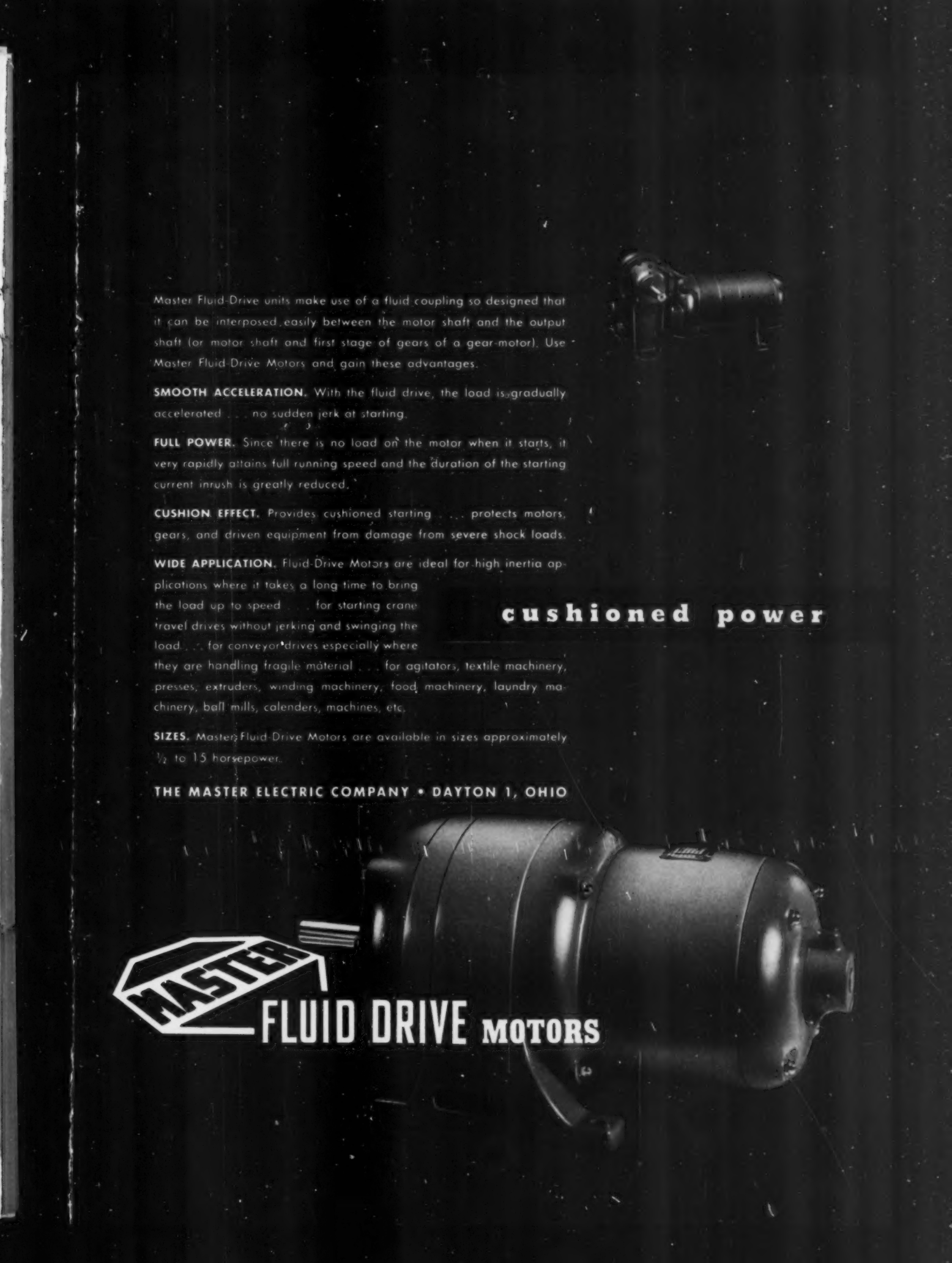

Master Fluid-Drive units make use of a fluid coupling so designed that it can be interposed easily between the motor shaft and the output shaft (or motor shaft and first stage of gears of a gear-motor). Use Master Fluid-Drive Motors and gain these advantages.
SMOOTH ACCELERATION. With the fluid drive, the load is gradually accelerated . . . no sudden jerk at starting.
FULL POWER. Since there is no load on the motor when it starts, it very rapidly attains full running speed and the duration of the starting current inrush is greatly reduced.
CUSHION EFFECT. Provides cushioned starting . . . protects motors, gears, and driven equipment from damage from severe shock loads.
WIDE APPLICATION. Fluid-Drive Motors are ideal for high inertia applications where it takes a long time to bring the load up to speed . . . for starting crane travel drives without jerking and swinging the load . . . for conveyor drives especially where they are handling fragile material . . . for agitators, textile machinery, presses, extruders, winding machinery, food machinery, laundry machinery, ball mills, calenders, machines, etc.
SIZES. Master Fluid-Drive Motors are available in sizes approximately ½ to 15 horsepower.
cushioned power
THE MASTER ELECTRIC COMPANY • DAYTON 1, OHIO
MASTER
FLUID DRIVE MOTORS

Turns, grooves, faces, bores with automatic accuracy on TIMKEN® bearings

A PLATEN type model, Gisholt's Simplimatic Automatic Lathe can accommodate a wide variety of tool arrangements, every slide with its own drive, rate and direction of feed, but all accurately driven and timed with the spindle. And because all machine functions are automatic, one man can normally operate several machines.

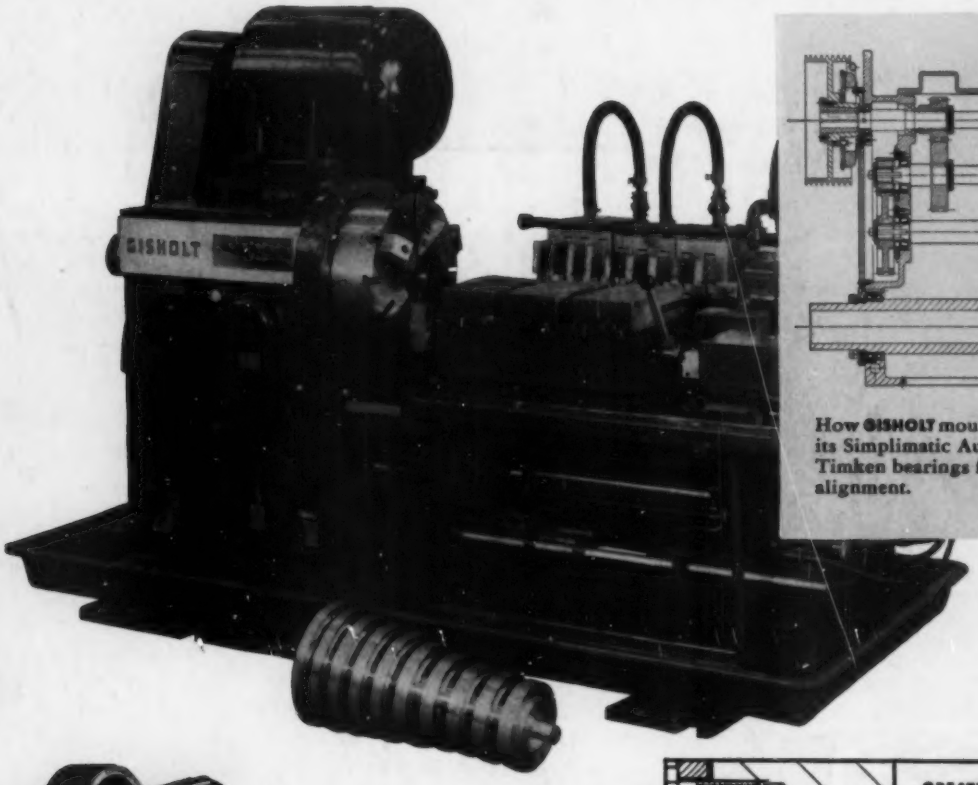
To maintain its incredible precision, Gisholt mounts the spindle and driving gears on Timken® tapered roller bearings. On the spindle, Timken bearings have a greater capacity for tool load because line contact between rollers and races provides load-carrying capacity to spare. Timken bearings in the headstock maintain alignment, help gears mesh accurately with less wear. A smooth flow of power is assured over a wide range of speeds and feeds.

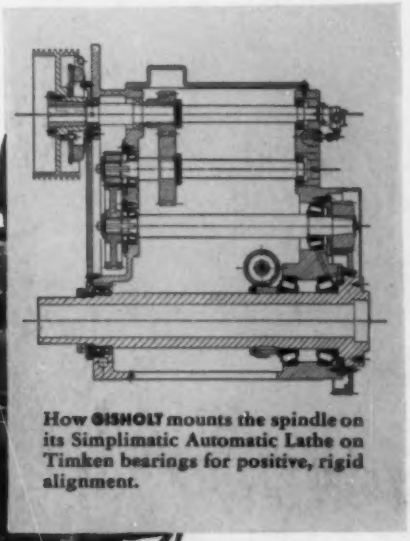
Timken bearings, because of their tapered construction, permit preloading to any desired degree, eliminating chatter. They are made for exacting spindle applications. "Double Zero" Timken bearings are available with maximum run-out tolerances of 75 millionths of an inch.

Timken tapered roller bearings on the spindle take radial and thrust loads in any combination, assuring spindle rigidity. Their true rolling motion and incredibly smooth finish practically eliminate friction. Wear is minimized and precision is maintained throughout the machine's moving parts.

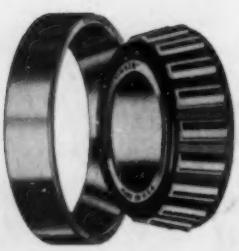
No other bearings can give you all the advantages you get with Timken tapered roller bearings. Make sure you have them in the machines you buy or build. Look for the trade-mark "Timken" on every bearing. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.





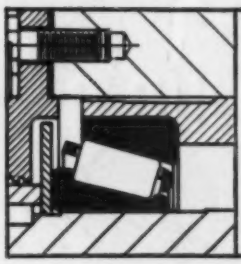
How GISHOLT mounts the spindle on its Simplimatic Automatic Lathe on Timken bearings for positive, rigid alignment.



TIMKEN

TRADE-MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS



GREATER ACCURACY FOR HIGH SPEED SPINDLES!

Timken bearings in new, semi-flexible mounting insure uniformly high spindle accuracy under varying speeds, loads, temperatures. It permits radial expansion without excessive preloading. Developed by the Timken Company, it's tested and proved. Write for full information.

NOT JUST A BALL ○ NOT JUST A ROLLER ⬭ THE TIMKEN TAPERED ROLLER ⬭ BEARING TAKES RADIAL ⓪ AND THRUST →⓪← LOADS OR ANY COMBINATION →⓪←